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The Impact of Financial Incentives on Urban-Rural Disparities in Dental Supply: Evidence From Thailand

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DEDICATION

To my beloved parents, Prayoon and Wilaiwan Noochpoung, I am eternally grateful for your wisdom, guidance, and support. There have been many times throughout my life that I have lost all hope in my work and no one else believed that I could succeed. Despite all the failures, you both were always there believing in me and pushing me on to where I am today. For that, I will never find the words and actions to thank you both enough. I would not be a fraction of the person I am today without your ever-loving words of encouragement.

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ABSTRACT

Financial incentive is one of the common strategies used to attract healthcare workers in rural and remote areas. Both high-income and low-income countries extensively use financial strategy to tackle the disparity distribution of healthcare workers. However, most studies were conducted in developed countries and assessed positive incentives programs. Previous studies showed the effectiveness of financial incentives on recruitment and retention of healthcare workers. Current studies show that most of the financial incentives supported for education such as scholarships and loan repayment programs are effective. A few studies assessed the effectiveness of direct payment incentive programs, especially in low-middle income countries. The evaluated studies of the effect of financial incentive reduction on the health workers' decision to stay or leave their practice location and the relationship between the health providers' age and their location choice after the reduction of financial incentive are required also.

This study have three specific aims. First aim is to examine the effectiveness of direct payment (Hardship Allowance) on retaining dentists in rural and remote areas. Second aim is to examine the impact of financial incentive reduction, due to the changed HA areas categorization, on rural and remote healthcare workers. The last one is to examine the relationship between dentists' age and dentists' location choice on financial incentive reduction, due to the recategorization of Hardship Allowance (HA) areas in Thailand.

A retrospective observational study was conducted for answering all three specific aims. Data used for aim#1 is the resignation data of dentists from 2003 to 2016 and an annual report on dentist's location. This data set were obtained from the Human Resource Management and the Policy and Strategy Bureau, Ministry of Public Health (MoPH) in Thailand. The fixed effect panel analysis and difference in difference regression was used to analyze the effectiveness of Hardship Allowance implemented in 2008.

Data used for aim#2 and #3 is the rural and remote dentist's location annual report, including the relocation and resignation from 2013 to 2018. This data set were obtained from the Human Resource Management Department and the Policy and Strategy Bureau at the Ministry of Public Health (MoPH) in Thailand. The difference in difference regression with fixed effect panel analysis was used to analyze the effect of Hardship Allowance reduction on dentists' decision to stay or leave their location. The triple differences regression with random effect estimation was used to analyze the panel data of dentists' resignation and relocation by age groups, in changed areas after the policy implementation.

Data from 2003 to 2016 showed that 2,351 dentists who resigned from the hospital under the MoPH. Over than 60% of resigned dentists were between 22-28 years old. The resignation rate from 2003 to 2016 showed that dentists who were located in rural areas had the highest rate compared with dentists in urban and remote areas. The highest resignation rate in rural areas in 2004 was at 29.4%. When the Hardship Allowance policy was implemented in 2008, the resignation rate started decreasing dramatically in all areas, but especially in rural areas. Additionally, the regression analysis showed that the resignation rate of dentists in rural areas significantly decreased

after 2008 at 10.09% (p-value <0.001), while in urban areas after 2008 the resignation rate decreased at 2.23% (p-value <0.001). Data of 2,384 rural and remote dentists is used to determine the location choice between the changed and unchanged areas categorization after the policy implementation in December 2016 which answer the specific aim#2 of the study. The outcome shows that the resignation of dentists in unchanged and changed areas is not significantly different. However, the relocation of dentists from rural to urban in changed areas after the policy implementation is more likely to increase significantly.

Data of 2,384 rural and remote dentists from 2013 to 2018 were used for specific aim#3 of the study. The percentage of dentists by age groups 22-28, 29-35, 36-45, and 46-60-year-old is 28%, 42%, 23%, and 5.4%, respectively. About 70% of 22-28-year-olds, and 29-35-year-olds are in rural areas, while approximately 60% of the other two groups are in urban areas. The regression analysis of dentists' resignation and relocation on dentists' age in changed areas after the policy implementation shows that the oldest group in changed areas is the less likely to resign significantly from their location after the policy implementation compared with the youngest group.

In conclusion, the study showed that after the policy implementation the resignation rate of dentists decreased in all areas. When comparing the resignation rate in rural and urban areas, the resignation rate in rural areas decreased higher than in urban areas after 2008. Therefore, the Hardship Allowance programs could retain dentists in rural and remote areas in Thailand. Furthermore, our findings show that the direct payment reduction does not affect the number of resignations, but the relocation of dentists. The dentists decide to leave their location after the direct payment HA reduction policy was implemented. Therefore, the reduction of financial incentives could

deteriorate the retention of health workers in rural and remote areas. We also found that dentists' age is related with the dentists' decision to leave or stay in rural and remote areas when the HA was reduced. Although, the policy implementation caused the reduction of financial incentives, most of the oldest group decided to stay in their practice location. Besides financial incentive, age is another factor that influences that the dentists' decision to leave or stay in rural and remote areas.

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LIST OF ABBREVIATIONS

CME ..... Continuing Medical Education

FFS……..……Fee-For-Service

FTE ..... Full-Time Equivalent

HA.....Hardship Allowance

HPSA ..... Health Professional Shortage Area

HR ..... Health Region

JMC..... Jefferson Medical College

MoPH.....Ministry of Public Health

MoUA ..... Ministry of University Affairs

NHSC.....National Health Service Corps

ONEC..... Office of the National Education Council

PSAP……...……Physician Shortage Area Program

RCSWA .....Rural Clinical School of Western Australia Program

RMED .....Rural Medical Education Program

UQ ..... University of Queensland

WHO.....World Health Organization

CHAPTER 1

INTRODUCTION

Human Resources for Health

The healthcare workforce is one of the most important inputs of a health system. According to the World Health Organization (WHO) Health System Framework, the health workforce is one of the six building boxes. These six building boxes are the basic functions of healthcare system and include service delivery, health workforce, information, medical product /vaccine /technology, financing, and governance (WHO report, 2000). Health system goals are improving health and health equity, by ways that are responsive, financially fair, and efficient (WHO report, 2000). To achieve these goals, all basic functions in the six building boxes must be implemented effectively.

To achieve the goal of improving population health, the government has to allocate qualified healthcare workers sufficiently and equally. For healthcare workforce, governments require qualified people with knowledge, skills, motivation and responsibility to organize and deliver quality health services. In addition, government is required to supply and distribute these qualified workers sufficiently and fairly in response to population health need and equity (WHO, 2007). Evidence showed the association between health worker density and health outcomes (Chen, 2004). For example, several studies found that areas with shortages in healthcare workers had high incidences of mortality, especially in children under five years of age (Chen, 2004; Hongoro, 2004; Lehmann, 2008; Grobler, 2015).

Several strategies have been implemented to supply qualified healthcare workers adequately, especially in rural areas. Many studies showed the effectiveness of educational strategies, for example the special admission program showed that choosing rural background students to health professional schools have potential to increase health workers in rural areas (Wibulpolprasert, 2003; Daniels, 2005; Halass, 2008). In addition, evidence showed that dentists, who attended in school containing a rural rotation curriculum, were more likely to practice in rural communities (Woloschuck, 2002; Capstick, 2002; Wilkinson, 2004; Halass, 2008). The Cadetship program in Australia which has the mandatory service contract for postgraduate training showed that 43% of program participants were practicing in rural areas compared with 20% of non-program participants (Dunbabin, 2006).

Evidence of the effectiveness of financial incentive programs for the healthcare workers is needed. In 2010, WHO suggested four major interventions to address health worker density issues including: education, regulatory, financial incentives, and professional and personal support strategies. Among recommended strategies, financial incentives are commonly used both in developed and developing countries. However, current evidence is insufficient to clarify the actual effectiveness of the programs especially in developing countries (Dolea, 2010; Barnighausen and Bloom, 2009; Grobler, 2015). This study proposed to examine the effectiveness of direct payment financial incentive to reduce pattern of the dentist resignation from rural and remote areas in Thailand. We expect to gain valid and reliable evidence to support policy makers comprehending and developing efficient strategy.

Disparities in Health Workforce Distribution

Geographic disparities in the distribution of health workforce affects the access for healthcare service for rural communities. The shortage and inequitable distribution of healthcare human resources is a global issue (Chen, 2004; WHO, 2010). Many countries have shortages in healthcare human resources for several reasons, including limited production capacity, deficient skills healthcare workers and migration of the health workforce within and across countries (Dolea, 2010). Providing people living in rural areas with access to a qualified healthcare workforce is a critical public health issue. Governments of both developed and developing countries have set goals to achieve health equity and to meet their populations' health needs particularly for vulnerable and disadvantaged groups (Dolea, 2010).

The uneven proportion of healthcare workers between urban and rural areas is apparent worldwide. Rural and remote areas remain some of the most affected by healthcare workforce shortages and disparities in access to care, both developed and developing countries (WHO, 2010). Statistics show that 50% of world populations are rural, while 24% of physicians worldwide are in rural areas (WHO, 2010). In the United States, data shows that 20% of the US population lives in rural areas, but only 9% of physicians are located there (Hancock et al., 2009). In urban areas of Canada and Australia, there are approximately 2.6 and 4.0 physicians per 1000 people, respectively, while in rural areas of both countries there are 0.9 physicians per 1000 people (Viscomi, 2013).

The disproportion is worse in many developing countries. In Pacific and Asian countries, the shortage of healthcare workers especially in rural and remoted areas is a

critical issue hindering efforts to improve population health outcomes. Many strategies have been implemented to diminish the shortage and maldistribution of qualified health workers problems, but the insufficient and inequitable distribution of healthcare workers is still a critical issue in these regions (Leymann, 2008; Henderson,2008). For example, in Vietnam at least 53% of physicians are located in urban areas while 72% of Vietnamese live in rural areas. Only 67% of rural health centers in Vietnam have a physician (Vujicic, 2011). In Cambodia, approximately 54% of physicians served in capital city, despite the fact that only 9.6% of Cambodians reside in Phnom Penh. In 2005, physician density in the urban areas was about 0.41 per 1000 Cambodian population while in the most remote areas the density of physician was only 0.06 per 1000 population (Chhea, 2010). Many countries in Africa also showed the unequal geographic distribution. For example, only 12% of physicians and 19% of nurses serve in rural areas of South Africa, despite the fact that 46% of citizens live in rural communities (Hamilton and Yau, 2004). The density of health workers in urban Tanzania is three times higher than in rural areas (Munga, 2014).

Strategies Used to Address the Healthcare Workforce Distribution Disparity

Several strategies have been used to attempt to attract health workers to rural and remote areas worldwide (Barnighausen and Bloom, 2009; Grobler, 2009; WHO, 2010; Dolea, 2010). These strategies were suggested by WHO in 2010 to attract, recruit and retain health workforce in rural and remote areas. Traditionally, governments have pursued four main categories for recruitment: education, regulatory, financial incentive, and professional and personal support.

1) Education, such as students from rural backgrounds, health professional school outside of major cities, clinical rotations in rural areas, and curricula that reflect rural health issues.

2) Regulatory, such as enhanced scope of practice, different types of health workers, compulsory service, and subsidized education for return of service.

3) Financial incentives, such as scholarship, loan repayment, or direct payment programs.

4) Professional and personal support, such as better living conditions, safe and supportive working environments, and career development programs.

For this study, we will focus on financial incentives. The strategy of providing financial incentives to rural physicians is used in many countries ranging from the US, Canada, Australia, New Zealand, Japan, and South Africa (Barnighausen and Bloom, 2009; Dolea, 2010). Besides examining the effectiveness of financial incentives, we will analyze how age and opportunity for continuing education influence the decision to leave the practice area. Both age and the opportunity for continuing education have been identified as important factors related to physicians' decision to leave or stay in rural and remote areas (WHO, 2010; Henderson, 2008). In 2012, Adzei examined the impact of financial and non-financial incentives for retaining health workers in Ghana. The study showed that both financial and non-financial incentives influence the retention of health workers significantly, and opportunity for continuing education was one of the significant non-financial factors.

Many governments have implemented financial incentive interventions to address the critical shortages of health workers despite insufficient evidence about the

effectiveness of the program and their long-term impact on retaining health workers in rural and remote areas. Other financial incentive interventions, such as scholarship and loan forgiveness programs for medical students working in rural and remote areas, were implemented and evaluated. The results from some studies found that participants in the programs were more likely to work in rural areas (see, e.g., Jackson, 2003; Holmes, 2005; Dunbabin, 2006; Matsumoto, 2008). In 2003, Jackson evaluated four financial incentive programs in West Virginia. The results showed that when comparing the obligated physicians who committed to serve in underserved areas and non-obligated physicians, the obligated physicians tended to be influenced by monetary factors in their practice decision of whether to deliver health services to uninsured patients. In 2005, Holmes examined the effectiveness of the National Health Service Corps (NHSC). The program was implemented by providing scholarship or loan repayment to medical students in exchange for agreement to practice in underserved areas. Holmes concluded that the program increased physicians in underserved areas, but he still had questions with the efficiency of the program which required more investigation. In 2006, Dunbabin evaluated the Cadetship program which offered bonded scholarship for medical students in Australia in exchange for service in rural areas for two years. The study showed that 43% of enrolled physicians remain in rural areas after completing service. In 2008, Matsumoto studied graduated physicians from Jichi University, which a university provides free tuition for medical students in exchange for agreement to serve in rural areas. The study showed that obligated physicians were three times more likely to practice in rural areas compared with non-obligated physicians.

Overall, the findings showed the effectiveness of attracting health workers to practice in rural and underserved areas. However, most evidence studied was from developed countries and focused on medical students or physicians (Sempowski, 2004; Barnighausen and Bloom, 2009; Dolea, 2010). In addition, most financial incentive programs analyzed in prior studies were scholarship or loan repayment programs providing educational support which had less flexibility for using money compared with direct payment program. Barnighausen and Bloom reviewed 43 financial incentives studies: 34(USA), 5(Japan), 2(Canada), 1(New Zealand), and 1(South Africa). Only five out of these 43 studies examined direct payment programs. More evidence from developing countries is required as well as evidence of financial incentives programs from other health professionals and evidence of direct payment programs evaluation. Such evidence can clarify the actual effectiveness of financial incentives programs. To create effective policies based on financial incentives, policymakers should have a deep understanding of the role of financial incentives in health workers location decision (Grobler, 2009; Dolea, 2010). This is the first study to analyze the effects of financial incentives for dentists in Thailand.

Financial incentives have been used to address geographic disparities in the distribution of health workers in Thailand**.** The government has implemented the financial policy to encourage healthcare workers to locate in rural and remote areas for more than two decades. However, there is little evidence of the effectiveness of the financial incentive program in Thailand especially in the dentist group. The Hardship Allowance (HA) has been implemented since 1998. The HA is the direct payment program that Thai government provides to health professional including: physicians,

dentists, pharmacists, and nurses who work in community hospitals under Ministry of Public Health (MoPH). The criteria and rate of payment is different among the health professionals. In this study we show the criteria and rate of HA payment for dentists only. The criteria and rate of HA payment have shown in Table 1 for HA rate before 2008, Table 2 for HA rate in 2008, and Table 3 for HA rate in 2013 and 2016. The program results have been described and analyzed the efficiency every 5 years since 2005 but there is no the effectiveness evaluated study. However, the disparity distribution could not be solved, and the data showed the increasing number of resignation dentists from 71 in 1999 to 103 in 2003 (Dental Department, MoPH, 2007).

The Thai government has implemented financial incentive strategies to retain qualified health professionals in rural public facilities. Hardship Allowance program is one of them that government implemented to reduce the income gap between private and public sectors. In 2008, the government started a huge revision of Hardship Allowance. The Hardship Allowance payment in Thailand in 2008 provided extra compensation to new physicians and dentists working in rural and remote areas representing about 100%-300% of their salary. This intervention made the income of new graduated dentists in rural and remote areas higher than new graduated dentists in urban areas (Pagaiya, 2015). The evaluated study of the effectiveness of Hardship Allowance program is required to provide the evidence to Thai government and other countries where have similar context.

Thailand context

Thailand is a lower-middle income country with 65.98 million people in 2010, (NSO, 2010). Most of the population (55.8%) resides in rural areas. Thailand geography

is categorized into four regions: Northern, Northeastern, Central and South. According to local administrative functions, the country is composed of 76 provinces, 877 districts and 7,255 sub-districts. Naturally, Thailand has three topographic regions: plain, highland, and mountainous areas. Most of the plain areas are in the Central regions, the highlands areas are in the Northeastern regions where the mountainous areas are in the Northern and the Southern regions.

Thailand Healthcare System

There are public and private health sectors providing healthcare service in Thailand. The government body responsible for the oversight of public health in Thailand is the Ministry of Public Health (MoPH). The health system in Thailand is dominated by the public sector. The main providers in rural and remote areas are authorized by the MoPH. The rural health system consists of district hospitals and sub-district health centers. In 2010, there were 734 community hospitals serving 83.6% of all districts. Besides the public sector, the private sector providers are scattered across the country but are congregated in urban areas (Pagaiya and Noree, 2009).

Dentists in Thailand

Distribution of Dentists

The Thai Dental Council showed that nearly half of dentists in the country are practicing in Bangkok while the rest of them distributed into four regions. From 2009 to 2010, statistics showed an increase in the number of dentists, but there is are disparities between Bangkok and other regions. This is a consequence of the government policy to increase the supply of health professionals especially in rural and remote areas in 2005. For example, in 2009 and 2010 the density of dentists was 0.16 and 0.19 per 1000

population, respectively. An unequal distribution of dentists has been shown. In Bangkok the density of dentists it was 0.86 per 1000 population. The density of dentists in Central, North, South and Northeastern regions excluding Bangkok was 0.11, 0.10, 0.09, and 0.06 per 1000 population, respectively (Thailand HRH, Sirilak, 2010).

Statistics showed the inequity distribution of dentists in Thailand. In 2013, the Dental Council of Thailand reported that there were 11,607 dentists for 64 million Thai citizens, creating a dentist to population ratio of 1:5,553 (Thai Dental Council, 2013). Data showed that over half of all dentists were in Bangkok and other big cities (50.9%). The dentist-to-population ratio in Bangkok, Central, North, South, and Northeastern regions was 1:1,039, 1:8,499, 1:9,147, 1:9,300, and 1:13,783, respectively. These ratios demonstrate that disparities in the geographic allocation of dentists occurred in some rural and remote area in Northern, Northeastern and Southern regions of Thailand, whereas urban areas benefit from a greater supply of dentists relative to rural areas.

To address the inequity in the geographic allocation of dentists, Thailand implemented three major strategies: educational, compulsory, and intensives strategies (Busarakamuha, 2016).

1. Educational strategies

The educational strategies include increasing dentists, special recruitment student from rural background origin, and curriculum reform. The first educational strategy was to admit more students into dental school to increase the number of trained dentists across the country. The shortage of dentists was reduced in the 1970s when the Ministry of University Affairs (MoUA) and the Office of the National Education Council (ONEC)

implemented plans to increase the number of dentists (Lexomboon, 2000). The second educational strategy was to recruit more rural background student through the special admission. The third educational strategy was developing clinical program to contain rural rotation curriculum. The dentist who attended clinical rotation curriculum were expected to have positive attitude for practicing in rural communities.

2. Compulsory strategies

The compulsory strategy was a policy required a compulsory service contract to assign newly graduated dentists to community hospitals, especially in rural and remote areas. 1989 was the first year that newly dentists had to serve in the community hospitals under MoPH for at least three years. Any newly graduated dentist who chose to opt out of the program had to pay a fine of $12,120.

3. Motivation/Incentive strategies

3.1 Financial Incentives

The policy was to provide financial incentives to retain dentists practicing in community hospitals, especially in rural and remote areas (Busarakamuha, 2016). The government implemented a direct payment program called the Hardship Allowance (HA) for dentists working in rural and remote areas. The HA payment has been implemented since 2001, but in 2008 the government increased the rate of payment. The rate and criteria of the HA payment were adjusted to be consistent with the economic growth of the country in both 2013 and 2016.

3.2 Non-financial Incentives

The non-financial incentives were composed of career development, specialist training/ continuing education and social strategies. The career development was a policy

to increase attractiveness for health workers to decide practicing in rural areas. For example, district dentists start career at level 4 and they are promoted to level 7 after approximately 8 years of service. The specialist training and continuing education provide opportunity for education for rural dentist as well as dentists in regional or central hospitals. A minimum for one year of service in rural area is required for most training. Rural and remote dentists have a special place for special training on the condition that they commit to continue serve in rural hospital graduated. The social strategy was the policy to create network for rural dentists so they can provide moral and technical support and to motivate recognition within the field. These three strategies are still in effect today.

Thailand Hardship Allowance Policy

Before 2008, the HA policy to attract healthcare professionals to work in community hospitals in rural and remote areas across Thailand had a tiered allowance system as shown in Table 1.1.

Hardship Allowance Policy change in 2008

The number of dentists increased between 2001 and 2008; however, the unequal distribution of dentists persisted. The resignation rate of dentists was also increasing (Dental department, MoPH, 2008). Financial incentive is the strategy chosen to decrease the resignation rate of dentists. Therefore, in 2008 the government increased the HA significantly, giving the highest direct payment incentive to dentists working in rural and remote areas as show in Table 1.2.

In 2008, the HA rate for dentists depended on years of service and practice area; for example, dentists who serve in urban and rural areas for 1-3 years would receive

Table 1.1 Hardship Allowance annually payment before 2008 by $US

Year of Service	Urban	Rural	Remote1	Remote2
First year	0	720	3750	7500
2 years up	0	938	3750	7500

$3,750 per year, while their cohorts who serve in remote areas would receive $7,500-$11,250 per year. The HA rate also increased for those who served longer in any community hospitals under MoPH; for example, dentists who served 4-10 years in urban and rural would receive $7500 and $11,250 per year, respectively. Compared with the HA rate before 2008, the HA rate for dentists located in rural areas after 2008 increased five times from the previous one.

The definition of rural and remote areas

At the present, there is no rural and remote definition which every country can apply (Matsumoto, 2008). There is no official definition of rural and remote areas in Thailand as well. The rural and remote areas, which are identified in this study, are applied from the MoPH identification (Appendix A). The classification of the MoPH for urban, suburban, rural and remote areas are used to determine the areas for the HA payment. The objective of the HA payment policy is to attract, and influence dentists to stay longer in the unattractive areas such as rural and remote areas. Therefore, the rural and remote areas which are identified by the MoPH, are the unpleasant areas compared with the urban and suburban areas. For example, the rural areas are further from the urban city and have less amenities such as commercial banks, convenience stores, private clinics, and so on, compared with the urban and suburban areas. In addition, many remote areas are the furthest from the urban areas and many of them are close to the border of the

countries, which have the least amenities and have difficult and inconvenient transportation.

Most of the rural and remote populations are lesser than the urban population. The distance between the remote areas and the city, in many provinces, are further than the distance between rural areas and the city as well. However, the classification of rural and remotes areas in this study do not comply with this common measure across Thailand. For example, the population in 2005, in some rural areas such as Chiangdao district, Chiangmai province is about 87,922 while in urban areas in Chiangrai or Loppburi provinces have lesser population at 68,198 (Wiangpapao district), and 77,005 (Banmi district), respectively. There is different distance among the urban, rural, and remote areas in each province as well. For example, the distance between Chiangdao district (rural areas) and Chiangmai city is about 86.5 km, while the distance between Pathumrat district (rural areas) and Amnartchareon province's city is about 31 km. Furthermore, the distance between Maeai district (remote areas) and Chiangmai city is 189.4, while the distance between Chanuman district (remote areas) and Amnartchareon province's city is about 65 km.

In 2013, the government adjusted the criteria for paying the hardship allowance (annually, US$) as shown in Table 1.3.

The hardship allowance payment structure has remained constant since 2013; however, in 2016, the government reclassified the rural/remote status of certain areas. Some rural hospitals became "suburban 1" or "suburban 2" and some hospitals in suburban 1 or 2 became urban in 2016. However, the criteria for hardship allowance

Table 1.2 Hardship Allowance annual payment in 2008 by $US

Year of services	Urban	Suburban	Rural	Remote1	Remote2
1-3 years	3750	3750	3750	7500	11250
4-10 years	7500	9375	11250	15000	18750
11-20 years	9375	11250	15000	18750	22500
21 up	11250	15000	18750	22500	26250

Table 1.3 Hardship Allowance annually payment in 2013 by $US

Year of services	Urban	Suburban1	Suburban2	Rural	Remote1	Remote2
1-3 years	3750	3750	3750	3750	7500	11250
4-10 years	4500	5625	7500	11250	15000	18750
11 up	5625	7500	9375	15000	18750	22500

payment remained the same as in Table 3. In other words, healthcare professionals working in some rural hospitals and suburban hospitals experienced a sudden drop in HA rates due to the reclassification of the rurality/urbanity of their hospital. Social and economic development caused the extension of urbanization in Thailand, so the MoPH must adjust the area to be consistent with the current economic situation. For example, in Chiangmai province 2016, 9 out of 13 rural hospitals became urban hospitals.

According the rate on Table 3 if young dentists who serve in rural areas less than 3 years when their practice place became suburban or urban areas their HA do not change. Then they may decide to stay. If the middle age dentists who serve in rural areas for 4-10 years when their practice place became suburban or urban areas, then they lost $3,750-6,750 per year. If the senior dentists who serve in rural areas for over 11 years

when their practice location became suburban or urban areas, then they lost $5,265-9,735 per year. If the middle age or senior dentist preferred high income when they lost, they might decide to leave the areas.

The adjusting HA areas categorization criteria followed the Notification of MoPH in December 2012. The Notification of MoPH identify that each provincial public health office has to reclassify the rural and remote areas in their province following the MoPH's criteria and submit the new list of rural and remote areas to the Strategic and Policy Bureau, MoPH. The MoPH's criteria for reclassification urban, rural, and remote areas in each province include transportation, urbanization, and health provider's shortage. The transportation criteria include both the difficulty to travel and the long distance from the district of the hospital to the urban city within the province or to the nearest urban city in another urbanized province. The urbanized provinces are the top 25 high income provinces in 2013 (Appendix C). The urbanization in each district can be measured by the number of amenities and the revenue of the district's government. The amenities in the district areas include commercial banks, private clinics, and convenient stores. The health providers' shortage criteria are the areas where are in the dangerous zone such as the areas in the three Southernmost provinces and the high turn overate of health workers' areas.

After the new criteria for reclassification the HA areas were announced, each provincial office collected and analyzed data. Consequently, the lists of the new area categorizations were sent to the Strategy and Policy Bureau, MoPH. Then the new lists were reported officially through the Notification of MoPH Issue #11 in December 2016 which is shown in Appendix B.

The Thai population growth rate and the MoPH dentist's growth rate from 2003 to 2016

According to the number of recruitments, resignations and overall dentists from 2003 to 2016, the average growth rates of recruitment, resignation and overall dentists are 4.06, 11.93, and 6.06 respectively. The average of resignation rate shows that dentists are more likely to resign. To address this issue, the government implemented the HA policy to increase retention of dentists in rural and remote areas. The HA policy was implemented in 2001 and had a big change in 2008 by providing a huge amount of payment rate. The HA policy was adjusted some payment rate and criteria in 2013 and reclassified some rural areas to urban areas in December 2016.

During the implementation of HA policy from 2003 to 2016, the educational and the compulsory service strategy are also implementing persistently. The educational strategy produces more graduated dentists and the compulsory service strategy recruits more graduated dentists to work in primary hospitals especially in rural and remote areas. As a result, the overall dentist's growth rate increase. The average growth rate from 2003 to 2016 is equal 6.06. At the same time the average Thai population growth rate is equal 0.24 (Official Statistics Registration System 2003 to 2016). The statistic shows that the dentists' growth rate outweigh the population growth rate. Therefore, in general Thailand have no shortage of dentist. The government have to persistently evaluate and monitor all strategies used to address the disparity distribution of dentists to prevent the oversupply of dentists in Thailand.

The Hardship Allowance Expenditure

Table 1.4 shows the estimated annual HA expenditure in 2009 and in 2013, respectively. The annual HA expenditure in 2009 and 2013 was about $18.7 and

$24 million, respectively. Although, the annual HA rate was reduced in 2013, the increasing of dentists caused the total annual HA payment increased. In 2019, the highest percentage group is the dentist who were in very remote areas and served for 1-3 years or were in rural areas and served for 4-10 years or who were in suburban areas and served for 11-20 years or who were in urban areas and served for over 21 years. In 2013, the high percentage group is the dentist who were in the rural, suburban, or urban areas who served 1-3 years.

Aim of the Study

Rigorous evidence is required to help policymakers understand the effectiveness of financial incentives on dentists' decision to remain in rural areas (Barnighausen and Bloom,2009; Dolea, 2010). Barnighausen and Bloom suggested that most of the financial incentive evaluated studies were from developed countries, so evaluated studies from more developing countries are required. Dolea commented on the disparity between physicians/medical student and other health professional's programs
and how there should be a more diverse array of health professional studies.

At present the information about the effectiveness of financial incentives to retain dentists in rural areas is limited, especially the effectiveness of financial incentives through direct payment method, when compared with the evaluation for the intervention involving educational programs (Dolea, 2010). More evidence of professional and personal support is also required (Dolea, 2010; Henderson, 2008). In this manuscript, I propose a study to examine the effectiveness of the financial incentives program for retaining dentists in rural and remote areas in Thailand. Besides, I propose to analyze the impact HA

Table 1.4 The estimated annual HA expenditure in 2009 and 2013

Year	Annual HA rate	Number of dentists	Percent	Total annual HA payment
2009	$ 3,750	496	26.7	$ 1,860,000
	$ 7,500	84	4.5	$ 630,000
	$ 9,375	243	13.1	$ 2,278,125
	$ 11,250	570	30.6	$ 6,412,500
	$ 13,125	10	0.5	$ 131,250
	$ 15,000	307	16.5	$ 4,605,000
	$ 16,875	14	0.8	$ 236,250
	$ 18,750	119	6.4	$ 2,231,250
	$ 22,500	16	0.9	$ 360,000
	Total	1859	100	$ 18,744,375
2013	$ 3,750	783	29.7	$ 2,936,250
	$ 4,500	102	3.9	$ 459,000
	$ 5,625	104	3.9	$ 585,000
	$ 7,500	255	9.7	$ 1,912,500
	$ 9,375	159	6	$ 1,490,625
	$ 11,250	655	24.8	$ 7,368,750
	$ 15,000	465	17.6	$ 6,975,000
	$ 18,750	81	3.1	$ 1,518,750
	$ 22,500	34	1.3	$ 765,000
	Total	2638	100	$ 24,010,875

Note: the money exchange rate using the rate in August 2018: $US 1 = 32 THB

reduction on dentists' decisions to resign from rural and remote areas based on their age as well as the opportunity for continuing education.

Evidence showed that age and opportunity for continuing education should impact the decision of dentist to resign from rural and remote areas when the HA decreased. Due to years of service which directly associated with age is one of two criteria of HA

payment rate in 2008, 2013 and 2016. As well as, the opportunity for continuing education has shown as the most common reason for dentists' resignation when excluded the reason for getting a new job (resignation data, 2003-2017). In addition, the opportunity for continuing education is one of the strategies the MoPH implemented to retain dentists in the rural communities (Lexomboon, 2003). There has been no formal evaluation of this program in Thailand.

The central hypothesis of this study is that direct payment financial incentives decrease the resignation rates of dentists in rural and remote areas, as indicated in Aims 1 and 2. A secondary hypothesis in Aim 3 is that Thailand's HA affected dentists working in rural and remote areas, based on their age, as well as the opportunity to continue their education.

To attain the overall objectives, the following specific aims will be pursued:

Aim1: To examine whether the HA payment in 2008 reduced resignation rates of dentists in rural and remote provinces relative to urban provinces.

Hypothesis1: After the HA policy in 2008, dentists in rural and remote provinces are less likely to resign. The resignation rates in rural and remote provinces after 2008 are decreasing compared with the resignation rates in urban provinces.

Aim2: To estimate the effect of the HA reduction, due to recategorization in HA areas from rural to urban in December 2016, on rural and remote dentists' resignation and relocation.

Hypothesis2: Rural and remote dentists who located in the changed areas which HA was reduced in December 2016 are more likely to leave (resign and relocate) from their areas. Therefore, after 2016, the resignation and relocation of dentists in changed areas increase.

Aim3: To examine the relationship between dentists' age and dentists' resignation and relocation in changed areas after the 2016 policy implementation.

Hypothesis3: Based on the policy change in 2016, the HA area was recategorized. Consequently, the HA payment rate was decreased. Rural dentists who are older affected the HA reduction more than the younger dentists. Therefore, the older dentists are more likely to resign or relocate from their areas due to the HA reduction compared with the younger dentists.

CHAPTER 2

LITERATURE REVIEW

This literature is composed of four major parts as follows: first is the description of the theories and model of health care workers geographic location. This part contains the theory of decision-making, and how it applies to the factors associated with the dentists' decision to leave or stay in rural and remote areas. The utility function of dentists' location choice has been shown in this section based on financial factors and non-financial factors. The second section is other theory related to the behavior and motivation of healthcare workers. The third section is the strategies used for addressing the disparities distribution of healthcare workers and the evidence of the effectiveness of these strategies. This section discusses the previous and current evaluated studies. The last section is the gap in the literature. Based on literature reviews from the previous three sections, this information and discussion can contribute to the knowledge gap of the study.

How Do Healthcare Providers Decide Where to Work: Theories and models of healthcare workers' geographic location decisions.

The Utility Theory: Theory of Decision Making

In 2005, Dussault suggested approaches to understanding the geographic imbalance of health workers which included economic and normative views. For the economics views, the distribution of health providers is a function of the health workers market

When there is an unequal supply and demand for workers in a given geographic area then the imbalance happens. Regarding the economic perspective, if wages increase, more health workers want to be employed and more people will go to the health providers, ultimately to a new equilibrium and a more balanced distribution of health professionals. The normative view explains the disparities as the health worker distribution compared with a standard or social norm. This norm can be considered by professional institutions, by policy makers, or by comparing with a certain region. Normative approaches normally apply full-time equivalent (FTE) ratios of physicians, nurses, etc., to population.

The normative and the economic perspectives complement one another. The description normative view focuses on the need and supply side, while the economic view approaches the demand and financial incentives. The study suggested approaching health worker geographic imbalance by combining these two perspectives, which is consistent with the utility concept. A previous study used utility theory to explain practice location preferences of health workers (Bolduc, 1996). The utility function assumes that a number of factors influence the providers' decision to locate in attractive areas and play a part in health providers' decision to locate their practice. The monetary factors are not only an essential part for health workers to choose practice location but other elements such as leisure time, proximity to family, and so on also relate to the preferences to choose the location of health workers.

In 1954, Edwards described the reasons individuals make choices among advantageous options. These theories focus on the concept of the subjective value, or utility, of all options, which the decider must select. The economists assume that people

have rational behavior. Then they have transitive preference and that they select in such a way as to maximize utility or expected utility. Early utility maximization the economists held that the goal of human action is to seek pleasure and avoid pain. Every object or action may be considered from the point of view of pleasure- or pain-giving properties. These properties are called the utility of the object, and pleasure is given by positive utility and pain by negative utility. The goal of action, then, is to seek the maximum utility. This straightforward self-indulgence of the future is simply converted into a theory of choice.

Economists measure a person's preference in term of utility. In 2009, Varians explained the utility model which economists can use for measuring the preference of an individual. Although utility mostly measures the consumer preference, healthcare worker preference can be measured by utility. The variation of geographic distribution of dentists in Thailand showed that dentists have different preferences in choosing their practice location. In this study, we apply utility theory to predict the effectiveness of the financial and non-financial preference of dentists on practice location choice.

Several studies showed the evidence of financial and non-financial factors that influence the practice location choice of healthcare workers. The extent of financial incentive is more definite compared with non-financial incentives. Financial incentives are all things related to money and income such as salary, salary supplement, benefits, allowance, etc., while non-financial incentives can be improved working and living condition, continuing education, training and professional development, management and supervision, opportunity for promotion, and so on (Henderson,

2008; Buykx, 2010). Several evidences showed the effectiveness of financial incentive program in attract health workers in underserved areas (Sempowski,2004; Barnighausen and Bloom, 2009; Dolea, 2010). While Henderson referred to salary, benefit, and allowance for financial incentives in Pacific and Asian countries, the financial incentives in Sempowski and Barnighausen and Bloom studied mostly were scholarship and loan repayment programs. Many evidences from developing countries showed the important of financial and non-financial factors integration to influencing health worker 's decision to practice in rural and remote areas (WHO, 2010; Humphrey, 2009; Grobler, 2015). For example, Evidences from Ghana and Tanzania showed the results from the survey of the healthcare workers in remote areas and found that financial and non-financial factors influence the motivation and retention of health workers (Adzei, 2012; Mungo, 2013). These evidences support the utility concept of health worker's preference for practice location choice especially in developing countries.

In this study, we apply utility theory in explaining the location choice of dentists in Thailand. We can consider a dentist as an individual. When they make a choice as to maximize their utility that means they gain the optimal satisfaction. The variation of the geographic allocation of dentists across Thailand showed that individual dentists prefer choosing practice location. Some dentists chose to locate in rural areas when the Hardship Allowance (HA) ,the direct payment financial incentive from Thai government, increased while others chose to practice in urban areas with low HA but close to many amenities and have more opportunities for continuing education. These

incidences can be explained by the utility maximization theory that the individual dentist chose the practice location to gain optimal satisfaction.

According to the utility theory, we simply theorize that a dentist chooses to leave or stay in rural and remote areas to optimize their preferences based on financial and non-financial factors. The simple utility function of dentists' location choice can be denoted as function (1).

$$U(\pi, x; \beta)$$

$$U = f(\pi, x; \beta) \quad (1)$$

Where

U is the utility function of dentist choice

π is the financial factors which in this study we estimate the effectiveness of the HA

x is non-financial factors

β is the vector of parameters

We adopted the WHO framework of factors related to decision to leave or stay in rural areas to account for the non-financial factors. From the WHO 2010 framework all factors included financial aspect, mandatory service, personal origin and values, family and communities' aspects, working and living conditions, and career related aspect. The 2010 WHO framework is shown in Figure 2.1.

Based on the 2010 WHO framework, other factors besides the financial aspects are considered the non-financial factors: personal origin and values, family and community aspects, working and living condition, career related aspect, and mandatory service. The framework of Thai dentist's location choice is established to comply

with the 2010 WHO framework. The framework of Thai dentist's location choice is shown in Figure 2.2

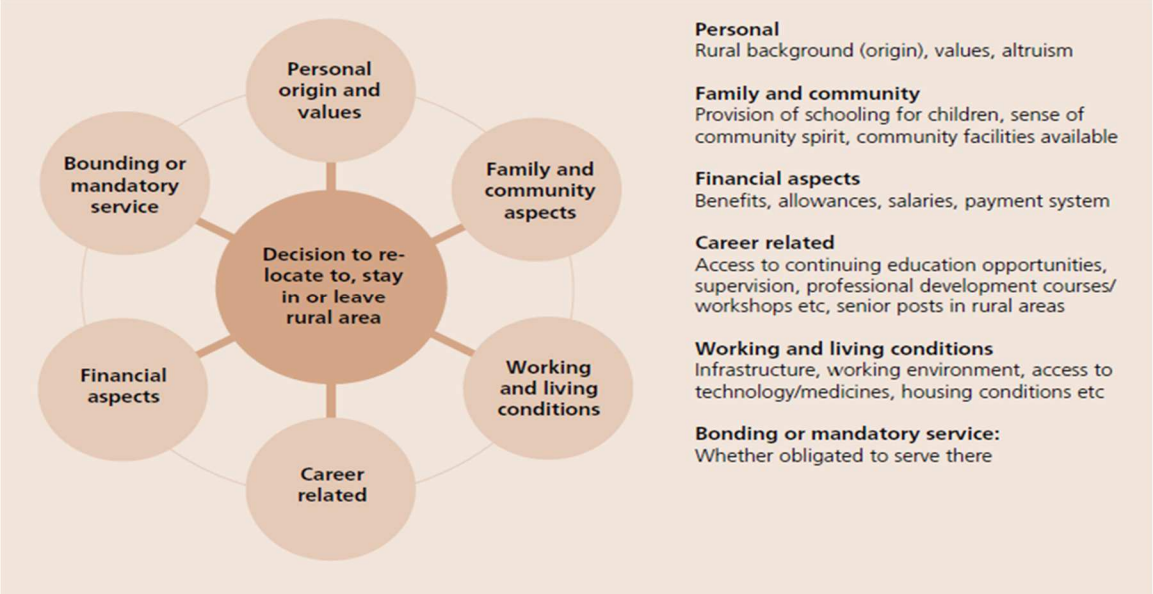

Figure 2.1 Factors related to the decision to leave or stay in rural and remoted areas

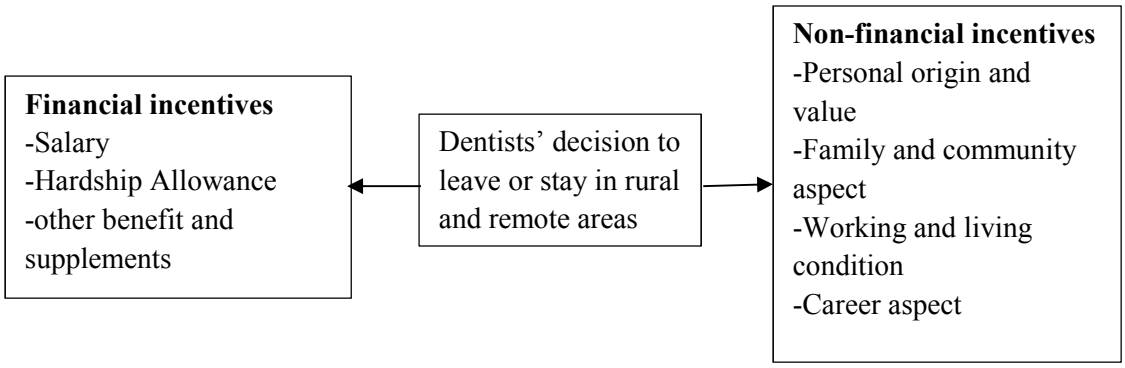

Figure 2.2 The model of Thai dentist's location choice

In this study, we aim to measure the choice of dentists to leave or stay in rural areas. We assumed that dentists' preferences, which affect the decision to leave or stay, included the financial and non-financial factors.

2.1 Financial factors

Financial incentive is a common factor among many factors listed in both developed and developing countries (Kruger, 2005; Danial, 2005; Henderson&Tulloch, 2008; Humphrey, 2009; WHO, 2010). The financial aspect of the WHO perspective includes benefits, allowances, salaries, and payment system. In 2009, Henderson showed that financial incentives for health workers in Pacific and Asian countries can be high salaries, salary supplements, benefits and allowances. Humphrey listed remuneration and salary packaging and benefits as financial incentives (2009). However, Barnighausen and Bloom categorized financial incentives in five groups based on programs' implementation to attract and retain physicians and other health workers in rural and underserved areas. Five categories of financial incentive programs included service-requiring scholarship, education loans with service requirement, service-option educational loans, loan repayment programs, and direct payment. While, most of evaluated study for financial incentive programs from developed countries reported the effect of scholarship and loan repayment program, many survey studies from developing countries reported the significance of wages, benefit and other compensation as an important factor for recruiting and retaining health workers in rural and remote communities. (Barnighausen and Bloom, 2009; Henderson, 2008; Dolea, 2010; Grobler, 2015).

Financial factor in term of salary, benefit, allowance, and other compensation is very important in many developing countries. Finance and benefit are considered the most important factors affecting the location decision of health professional especially in countries where the salary from the government is not enough for basic living

expenses (Henderson, 2008; Lehmann, 2008). The financial incentives are very important motivating factor for health workers in the countries where low salaries and benefits. For example, the survey of geographic location of physicians in Vietnam showed that most Vietnam physicians (53%) practiced in urban areas. The study showed that most physicians in Vietnam have second jobs for gaining satisfied income. It was suggested that to remain Vietnam physicians in rural areas, the government must recruit them to rural communities by providing high salaries and benefits in the first place (Vujicic, 2011). In addition, the questionnaire surveys of medical students from Congo, Kenya, Nigeria, Tanzania, and Uganda showed that 96% of participants answer the most important reason to leave Africa is the low salary (Burch, 2011).

In this study, we model utility function to predict the dentists' decision to leave or stay in rural and remote areas which influencing by direct payment method 'Hardship Allowance'. A model of financial factors based on dentist's location choice utility function can be denoted as function (2)

$U(\pi)$ is the utility function of financial factors

$$U(\pi) = f(HA, S, O;\alpha) \quad (2)$$

- HA=hardship allowance
- S = salary
- O=other compensation, benefits
- α is the vector of parameters

2.2 Non-financial factors

Based on the 2010 WHO framework, the non-financial factors include personal origin and values, family and community aspects, working and living condition, career

related, and mandatory service. A model of non-financial factors based on dentist's location choice utility function can be denoted as function (3)

U(x) is the utility function of non-financial factors

$$U(x) = f(P,F,W,C,M; \Upsilon) \quad (3)$$

- P = personal origin and values
- F=Family and community
- W=working condition
- C=career related
- Υ is the vector of parameters

In term of non-financial factors in this study, we propose to measure how can age and opportunities to continuing education associated with the direct payment financial incentive 'Hardship Allowance' predict the location choice of the dentists in Thailand. So the utility function of our proposal model can be denoted as function (4).

$$U(D) = f(HA, A, O; \varrho) \quad (4)$$

- D= Dentists decision to leave or stay in rural and remote areas
- HA=Hardship Allowance
- A=Age of dentists
- O=Opportunities to continuing education

2.2.1 Personal origin and values

2.2.1.1 Rural background

As shown in Figure1, personal factors include rural background (origin), values, and altruism. Many studies showed the effectiveness of selection rural background students to study in medical or other healthcare professional schools (Daniels,

2005; Halass, 2008; Suphanchaimat, 2016). In 2009, Wilson showed the strong impact of geographic origin on retention of healthcare workers in rural and remote areas. The studies of rural clinical rotations programs for medical students at the University of Calgary and pharmacy students in New Zealand showed that rural origin students were more likely to choose rural practice than urban origin students (Wolschuk, 2002; Capstick 2008).

2.2.1.2 Rural upbringing

Evidence showed that physicians who graduated from schools that contained a clinical rotation curriculum were more likely to practice in rural and remote areas (Woloschuck, 2002; Capstick, 2002; Halass, 2008). In addition, graduated students from schools located in rural areas showed the same results (Mathew, 2008). Graduated students gained values and altruism to work in rural and remote areas from clinical rotation curriculum schools and school located in rural areas.

Although the WHO framework did not clarify what is personal origin and value, based on Lexomboon in 2003, personal factors included age, year of service, educational level, gender, marital status and children, and other personal factors. In 2008, Lehmann explored the relationship between attraction and retention factors on healthcare worker decisions for practice areas. He presented that individual factors such as origin, age, gender and marital status may have an impact on health professional decisions.

2.2.1.3 Age

A differing connection between age and practicing location decisions was found (Lexomboon, 2003). Generally, relationships between the decision for leaving a practice location and demographic characteristics such as age, gender, education

level are indecisive (Lehman, 2008). In 1990, Easterbrook explored how factors influenced family medicine location decisions and found that age was no significant factor on physician decisions. However, the study of the impact of job satisfaction on worker turnover found that the higher the age of the workers the more likely they are to leave their present work (Lamber, 2001). In 2005, Richards showed there was a high percentage of older health workers (>50 years) practicing in rural areas, while another one reported the average ages of health workers in urban and rural areas were 36.1 and 36.8, respectively (Richards, 2005; Ebuehi, 2011). In 2013, Antwi identified the impact of wages on the retention of health workers. The author stated that age was important and focused on young adults aged 20-35-years old (Antwi, 2013). These studies showed the various results regarding the relationship between age and health worker's decision. Evidence is still required to show the actual association of age on practice location decisions of the healthcare workforce.

2.2.1.4 Year of service

A study examined the relationship between job satisfaction and intention to leave the practice areas and showed that the tenure had negative association with job satisfaction. When the tenure increased, the job satisfaction decreased (Lamber, 2001). However, the study evaluated a skills training program for rural retaining physicians in Alberta, and data showed that the more years of practice, the less likely the physicians are to leave rural locations (Gorsche, 2012). As same as the age factor, to clarify the relationship between years of service and the health worker's decision to leave rural and remote areas, more evidence is required (Lexomboon, 2003).

2.2.1.5 gender

The association between gender and retention of health workers in rural and remote areas is also inclusive (Lehman, 2008). In 2001, Lamber showed males had lower job satisfaction than females; however, there was no significant difference in decision to retain in rural areas between males and females. There was also no significant difference between male and female physicians working in rural areas from the national survey of retention of primary care physicians in rural health professional shortage areas, as well as male and female residents at a rural setting who were more likely to practice general surgery than specialists (Pathman, 2011; Deveney 2013). However, in 2005, the survey of primary healthcare workers in rural areas in Scotland reported that 81% of respondents were women (93% of nurses, 52% of doctors, 33% of dentists and dental nurses, and 91% of other health professionals) (Richards, 2005). In addition, the medical students participating in the Cadetship program which offers scholarships in exchange for serving at least 2 years in rural areas were mostly female (60%) (Dunbabin, 2006). Different results in the study examined the impact of wages on retention of health workers showed that more men, responded to the increasing wages than women (Antwi, 2013). Wilson reviewed the interventions to address the disparity distribution of healthcare workers, and also concluded that men are more likely to practice in rural and remote areas than women (Wilson, 2009).

2.2.2 Family and community

According to the WHO framework, provision of schooling for children, sense of community spirit, and community facilities available are included in this group.

Some articles included the family factor such as marital status to be classified in personal characteristics (Lexomboon, 2003).

2.2.2.1 Marital status

Many evidences showed the association of marital status and the decision to leave rural remote areas. For example, in 2003, Viscomi's study in Australia showed that physicians were likely to practice in a rural area if they had a partner with a rural background. In 2009, Stagg identified influential factors for career choices of the South Australian Flinders University Parallel Rural Community Curriculum graduated students. The study found that graduated students who had a rural background spouse/partner were more likely to choose practicing in rural locations. In 2012, Royston surveyed new osteopathic medical students to examine the factors related to decision to practice rural areas. He found that besides rural upbringing factors, students who have a spouse or significant other who had lived in rural areas were more likely to intend to practice in rural areas.

2.2.2.3 Provision of school for children

In 2007, Serneel showed that access to education for children was the most significant factor that affected the location decision in rural areas of nursing and medical students in Ethiopia. In 2003, Viscomi summarized many reasons influencing family physicians to remain in rural areas, including childcare and provision of school for their children.

2.2.2.4 Sense of community spirit

In 2009, Christine reported that 'rural upbringing' was related to the tendency of health workers to choose to practice in rural areas. The study explained that rural

childhood experience made the health workers familiar and resilient to integrate the community which drives them to their interest in rural community. Hancock tested whether the rural upbringing could be a predictive factor for recruiting and retaining physician practice in rural areas by using a qualitative method study. The results showed that rural exposure through recreation, education, long-term residence, or a mixture of these, contributes an early creation or familiarity, resilience, and community/place integration that bring attentiveness for graduated physicians practicing in rural areas (2009).

2.2.3 Working and living condition

2.2.3.1 Working environment: relationship in working place, work load,

Work environment is one of the major non-financial factors influencing the decision to leave or stay in rural of health providers (WHO, 2010; Lexomboon, 2003). Many studies group this factor to non-financial incentive which related the retention of health worker practicing in rural communities (Henderson, 2008; Adzei, 2012; Awofeso 2010). Working and living conditions are very important in many developing countries. Due to the budget constraint, the government in many developing countries strengthen their incentive policy by combining financial incentives with improving working and living conditions in rural and remote areas (Henderson, 2008). For example, the financial and non-financial incentives have been used and evaluated in Ghana. The study showed that both incentives significantly influenced the location choice of healthcare workers (Adzei, 2012). The significant non-financial incentives in Ghana included leadership skills, opportunity for continuing education, and availability of infrastructure and resources. The difficulty in rural and remote areas, such

as limited access to electricity, primitive social amenities, poor quality educational or communication facilities and inadequacy of portable water are all barriers to deciding to practice in rural and remote areas of health workforces. Improving these difficulties can reduce the decision to leave rural areas of healthcare workers in Nigeria (Awofeso, 2010).

2.2.3.2 Job satisfaction

In 2010, Delobelle explored the Southern African nurses whether job satisfaction related to their decision to leave or stay in rural areas. The survey study showed that job satisfaction significantly associated with retention in rural area. The survey of health worker in Ghana showed the same result as the study in Southern African nurses. The survey showed that job satisfaction significantly reduced the intention of health workers to leave the rural areas (Boneburger, 2014). The same scenario with the study in Thailand, in 2003, Lexomboon explored the factors causing Thai dentist leaving their practice location. The study showed that job satisfaction was one significant factors influence dentists decide to leave their location.

2.2.4 Career related aspect

The opportunity for continuing education or training was most common important motivated factor reported from health workers questionnaire survey (Grobler, 2015). The WHO framework showed some examples of career related factors including access to continuing education opportunities, supervision, professional development courses and workshops, and so on. In 2007, Serneels explored the factors affecting location decision of nurses and medical students in rural areas in Ethiopia. The results showed that the opportunity for promotion was a highly significant factor for nursing students' location

choice, while having access to training was more significant to medical students' location choice. The survey of medical students from six countries in Africa showed the reasons to stay in Africa most involved with career related aspect. Medical students from Congo, Kenya, Nigeria, Tanzania, and Uganda were choosing to stay in Africa because of good career options 92% and opportunity for further education 88% (Burch, 2011). In 2012, Adzei identified the opportunity for development as one significant influential factor for the health workforce in Ghana. The study showed that the opportunity for development could be a predictor for motivation and retention of health workers in rural areas.

2.2.5 Bounding or mandatory service

The bounding or mandatory service factor can be called several names for example, compulsory service, obligatory, mandatory, requisite and coercive programs. This program has occurred since the early 1900s (Frehywot). The mandatory service program has been implemented in many countries around the world for recruitment and retaining health workers in rural areas in their country. Frehywot represented that there are three different types of mandatory service programs in 70 countries. They are the condition of service program, the mandatory service with incentives program, and the mandatory service without incentives program. The mandatory service with incentives program is the program generally used in many countries. We can notice that the mandatory service program is associated with financial incentives used in many developed countries (Pathman, 2004; Jackson, 2003; Dunbabin, 2006; Matsumoto, 2008). The evidences showed that obligated participants who committed to serve in rural areas in exchange for scholarship or loan repayment, were

more likely to practice in a committed location. The studies showed that some obligated health workers chose to stay in the original location after completing their commitment (Cullen, 1997; Jackson, 2003; Matsumoto, 2008).

Other Theories Associate the Movement Behavior of Health Workers

1. Extrinsic and Intrinsic Motivation

According to Judson's study, the topic is "Harnessing the Right Combination of Extrinsic and Intrinsic Motivation to Change Physician Behavior." The study showed the effort of the policy makers to change physicians' behavior. The policy makers implemented strategies to improve efficiency in the production of health with extrinsic and intrinsic motivations. Both extrinsic and intrinsic incentives were provided to improve provider behaviors. The problems were the difficulty to assess the achievement of these incentives in behavior change. Many arguments occurred among the policy makers about how and when extrinsic and intrinsic incentive should be implemented to optimize provider behavior (Judson, 2015).

Judson suggested four types of extrinsic and intrinsic motivators. They are including successful extrinsic motivation, extrinsic motivation "overpowered" by intrinsic motivation, successful intrinsic motivation, and intrinsic motivation "crowded out" by extrinsic motivation.

1. Successful extrinsic motivation: the evidence showed that the behavior of physicians improved after changing the payment method. The salaried physicians who used to ignore clinical assignment and sometimes avoid taking care of patients began improving their practice and responsibility when implementing fee-for-

service (FFS) payment system. This shows that the financial incentives affected the behavioral change of physicians.

2. Extrinsic motivation "overpowered" by intrinsic motivation: the article showed one example: the chief of one medicine institute offered financial reward for faculty member who attend the medical grand round at least 50%. He expected to increase the round attendee. However, some mid-career physicians felt insulted and denied attending the medical grand rounds. This example showed that financial reward cannot overcome by intrinsic motivation. This situation can be used to explain how to attract healthcare workers practicing in rural and remote areas by using financial incentives and non-financial incentives.

- Successful intrinsic motivation: the evidence showed many physicians volunteered to work in West Africa in 2014 to provide healthcare service for patients infected with Ebola. These volunteer physicians risked themselves working in the dangerous areas to help other people because they believed the worthy and significance to saving people's lives. They said they receive huge happiness for helping people's lives with no compensation.
- Intrinsic motivation "crowded out" by extrinsic motivation: the evidence showed the physician who used to sacrifice his time and effort for helping HIV/AIDs patients to have a better quality of life. However, after many years of his dedication, he learned that he received lower income compared with many new physicians. Ultimately, he stopped serving HIV/AIDs patients then worked in hospital medicine, which provided him with higher income.

These models explained how both extrinsic and intrinsic motivators can be effective or ineffective, based on the context and expectations. For example, FFS physicians are more likely to increase the volume of care, while salary physicians feel adequately compensated, so financial incentive may insult their professionalism. Intrinsic motivation may be a proper way for changing behavior. This model provides a wide perspective in considering the behavioral changes of providers from the extrinsic and intrinsic incentives.

2. Motivation and Behavior Psychology Theories

The behavior psychology approach is commonly used in the article of healthcare workforce geographic location from the management discipline. Basically, motivation theories are applied by management to change worker behavior. According to the conceptual model of this study besides the financial incentives such as Hardship Allowance, the non-financial incentives such as personal origin and value, family aspect, working and living condition, and career related are associated with the decision to leave or stay in rural areas of dentists. The non-financial incentives we focused in this study are personal age, and opportunity for continuing education whether they affect the decision of dentists to leave the practice communities.

The Maslow's Hierarchy of Needs

This is a classic theory which explained the needs of human being are categorized into five levels from lower to higher hierarchy (Dempsey, 1999).

Level 1: Physical needs, such as the material need for food, drink and shelter

Level 2: Safety needs, such as protection from danger

Level 3: Belonging needs, such as friendship and social compatibility

Level 4: Esteem needs, for respect, reputation and autonomy

Level 5: Self-actualization needs, expressed as the realization of one's potential

The theory shows that individuals have a hierarchy of psychological needs. The higher-level needs will not be important unless the lower-level needs are filled. Health provider is a human being which have need as same as other people. To cover the basic need in level 1, the health provider have to sufficient income and have financial security. After they are fulfilled the level 1 need then they increase their need in the next level.

The Herzberg's Motivation Theory

According the theory, motivators and work environmental factors are related to job satisfaction (Robbin, 2001). Job satisfaction is related to decision to leave the practice location (Lexomboon, 2003). Motivating factors can be achievement, recognition, type of work, responsibility, advancement, and opportunity for continuing education. Work environment factors can be primary hospitals policy and administration, supervision, relationship with supervisors, work condition, salary, relationship with co-worker, personal life, status, and security. The health worker will be dissatisfied with work if their hygiene factors do not meet their expectation.

Human behavior theory

Several theories such as intuitive theories, reinforcement theories, motivation theories, and theories of learning can be used to describe human behavior (Fincham and Rhodes, 1992). All these theories show that behavior is affected by stimulus. For example, family factors such as spouse's job, children's schooling, higher household income can influence the decision of healthcare worker leave or stay in rural and remote areas. The opportunity for continuing education is one of the motivating factors; and our

study is interested in how it relates to financial incentive for dentist working in rural and remote areas in Thailand.

Addressing the Healthcare Worker Disparities Distribution: Strategies used and the effectiveness

In 2010, WHO suggested intervention to improve attraction, recruitment, and retention of health workers in rural and remote areas. There are four major categories of interventions: education, regulatory, professional and personal support, and financial incentives.

Educational strategies

In 2010, Dolea reviewed the evaluated strategies to increase attraction and retention of health workers in remote and rural areas. She suggested that education strategies had influenced mainly on the attractiveness of rural and remote areas. Therefore, it is necessary to choose desirable students, those who are probable to work in rural and remote areas. Those who will be trained in these locations with applied methods and programs that tend to convince them decide to work in rural areas. The example of intervention in the education category can be: students from rural backgrounds, health professional schools outside metropolitan areas, clinical rotations in rural areas during studies, curricula that reflect rural healthcare problems, and continuing professional development for rural health workers.

a. Recruiting student from rural origin, underserved population

Students with a rural origin are more likely to practice in a rural setting. Evidences show that students with a rural origin are more likely to practice in a rural setting, which is a consistent finding in many studies. It appears to be the single factor

most strongly associated with rural practice (Wilson, 2009; Dolea, 2010). The survey of medical students who participate in Australian Rural Clinical Schools Program showed that rural background medical students were 10 times more likely to prefer working in rural areas compared with non-participants (Walker, 2012). Thai government also applied the educational studies for addressing the inequitable distribution of physicians. The medical schools recruited rural background students by special admission (Wibulpolprasert, 2003). The geographic origin selection intervention is the most strongly related with rural location (Wilson, 2009).

b. Clinical rural rotation curriculum

In 1999, Rabinowitz investigated physicians who graduated from Jefferson Medical college which contained the Physician Shortage Area Program (PSAP). His longitudinal cohort study showed that PSAP graduates were four times more likely than non-PSAP graduates to locate in rural and underserved areas. The study which examined the Rural Medical Education Program (RMED) which started in 1989 by placing students in a rural community of New York, showed that about 25% of physicians from RMED working in underserved communities (Sumchy, 2005). In 2004, Tani evaluated the community-based medical education in medical students in Tokushima Prefecture Japan, the study clarified that the intensity of students' attitudes about interest and a sense of fulfillment in community medicine and medicine in remote area was significantly increased after the community-based practice. The study of the impact of rural clinical division of the school of Medicine at the University of Queensland (UQ) found that UQ's rural clinical division is having a positive impact on the intern workforce in the regional hospitals most closely allied with it (Wilkinson,2004).

The Medical Education (RMED) Program from University of Illinois, which provides the long ambulatory training for medical students, showed the program achievement by 68% of program participants practicing in rural Illinois (Salafsky 2005). In 2007, White evaluated how access to continuing medical education (CME) in Australia is important and impacts the retainment of physicians in rural communities. He found that the access to CME increased the confidence of physicians' remaining in rural areas. In 2008, Halaas examined the Rural Physician Associate Program in Minnesota. The nine months longitudinal experiences in rural communities induced more medical students to choose to practice in rural areas. The rural rotation experiences influenced health professional students to be more likely to choose locating in rural communities, especially rural background students (Wolschuk, 2002; Capstick 2008). In 2014, Playford determined Rural Clinical School of Western Australia Program (RCSWA) which contain rural clinical program. The study showed that participant in RCSWA program strongly associated with greatly likelihood for working rural areas.

c. School location in rural area

The study showed that the new physicians who graduated from Memorial University Medical School, which is located in a rural area in Canada, were more likely to practice in rural communities, especially those who have a rural background (Mathew, 2008). In 2011, Rabitnowitz evaluated the Physician Shortage Area Program (PSAP) of Jefferson Medical College (JMC) to show the effective of program impact on female physicians. The study showed that female physicians who participated in PSAP were more likely to practice in rural areas compared with non-PSAP female. The result support the

effectiveness of the medical school rural programs that have the potential to recruit more female physician practicing in rural areas.

Regulatory strategies

These strategies can be called several names including "compulsory service," "obligatory," "requisite," and coercive" programs. These programs have been used worldwide since the early 20th century to recruit and retain health professional in rural areas in their countries (Frehywot, 2010). The regulatory strategy has been implemented in many countries worldwide for recruitment and retaining health workers in rural areas in their country including Thailand. According to Frehywot article, the regulatory programs were classified three types using differently in 70 counties: 1) condition of service, 2) compulsory service with incentives, and 3) compulsory service without incentives. The common one is the mandatory service with incentives program, due to this program being associated with financial incentives used in many developed countries (Pathman, 2004; Jackson, 2003; Dunbabin, 2006; Matsumoto, 2008). These evidences showed that participants who received financial support in exchange for committed to serve in rural areas were more likely to retain in rural areas than the non-participants were.

Dolea summarized that some evidences showed that mandatory strategies could recruit and retain health workers in rural and remote areas. In 2003, Jackson examined a West Virginia scholarship and loan repayment program, which required medical students to commit to serve in underserved areas after graduating. The study showed that committed physicians were more likely to stay in their started practice place than were non-committed physicians. In 2006, Dunbabin showed the investigation

of the Cadetship program in Australia, which has a bonding scheme for postgraduate training where 43% of participated physicians were locating in rural areas, compared to 20% of all national physicians. The bonding scheme from the National Health Service Corps and Oklahoma's physician loan repayment/incentive program in USA as well as the Jichi Medical University home prefecture compulsory scheme in Japan showed the influential retention (Cullen, 1997; Matsumoto, 2008). However, many bonding schemes or compulsory services as in the West Virginia program, Cadetship program, NHSC and Jichi Medcial University programs involved with scholarship and loan repayment required services which are considered financial incentives intervention also (Jackson, 2008; Dunbabin, 2006; Cullen, 1997; Matsumoto, 2008).

Professional and personal strategies

In 2010, Dolea suggested that professional and personal factors were the top choice and preference for work in rural areas. Questionaire-based surveys show that professional and personal support may affect health workers' decision to practice in underserved areas (Grobler, 2015). In 2008, Lehmann showed that poor living condition and insufficient health care and education facilities were associated with the reluctant to practice in rural and remote areas.

In 2006, Gardiner evaluated the impact of a rural doctor workforce program. The program involves social and psychological support and practical interventions, on the well-being and retention of general practice physicians in rural areas. The study showed that the enrolled physicians were less likely to leave rural communities in the short to medium term (from 30% to 25%) (Gardiner, 2006). In 2012, Adzei examined the motivation and retention of healthcare workers in Ghana. He reported that besides

financial incentive, non-financial incentives also significance influence motivation and retention to locate in rural. These non-financial incentives were leadership and supervision skill, continuing professional development, and infrastructure and resource.

Financial strategies

Evidences showed that financial incentives have influential attractiveness, recruitment and retention for health workers in rural and remote areas (Gibbon, 2006; Niger Ministry of Health, 2008; Dolea, 2008). Evidence of financial incentives programs were from developed and developing countries. Based on the literature review in part one about factor attracting and retaining health workers in rural areas, many articles were from developing countries report the important of financial factors. However, when review the literature about the effectiveness of financial incentive program to recruit and retain health workers in rural areas, many articles were from developed countries.

Financial incentives programs from developing countries mostly were direct payment program. The evidences showed that the financial programs and evaluation from developing countries was very rare compared with the evaluated program from developed countries (Dolea, 2010; Grobler, 2015). In 2007, Ross examined the Friends of Mosvold Scholarship Scheme from South Africa. The results found that 100% of participants completed their committed service in underserved areas. In 2011, Ditlopo evaluated the rural allowance policy in North West Province, South Africa by interviewing 40 health workers from five rural hospitals. The results showed the rural allowance affected to the increasing of health workers in rural areas, but most staff showed program dissatisfaction. In 2013, Antwi investigated the effective of raising public sector wages program in Ghana. The study found that increasing wages 10% could

decrease 1.03% health worker rural leaving rate. Not only the number of studies from developing countries is lesser than studies from developed countries, but also the quality of the study that required more rigorous study from developing countries (Dolea, 2010; Grobler, 2015).

Financial incentives program from developed countries mostly were scholarship and loan repayment program. Most of previous and current financial incentive evaluated studies were from developed countries (WHO, 2010; Dolea, 2010; Humphrey, 2009; Grobler, 2015). For example, the review article of Barnighausen and Bloom showed that among 43 studies, most of them were from the US, five of them from Japan, two from Canada, one from New Zealand and another one from South Africa. Among 34 articles from the US, 24 articles examined the effectiveness of National Health Service Corps programs which provide scholarship for health professional students and loan repayment for young health professionals. The Jichi Medical University program from Japan was also the scholarship for medical student program. The Ontario Underserviced Area Program from Canada contained both scholarship for medical students and direct payment for physician. However, most of the financial incentives program from developed countries were scholarships and loan payment programs while program from developing countries were direct payment program.

The evaluated program used utility theory explain the location choice of health workers. In 1996, Bolduc estimated the model of choice of location by general physicians for establishing their initial practice. The model used to assess the effect of various incentive measures introduced in Quebec to influence the geographical distribution of physicians across 18 regions. Bolduc measured choices of location of the physicians in

Quebec before and after the intervention and used autoregressive multinomial probit model analyses data. Bolduc used utility theory explained the incentives policies to maximize utilization of physicians to practice in the areas. The results provided evidence that these policies had a significant effect on location choices.

The effectiveness of the financial incentive program was explained by program outcome. In 2004, Sempowski reviewed the effectiveness of financial incentives in exchange for rural and underserved areas. He summarized the effectiveness of financial programs from 10 articles. The results showed that the return-of-service programs to rural and underserviced areas have achieved their short-term recruitment goal while the long-term retention has less achievement. Barnighausen and Bloom reviewed the evaluated financial incentives studies conducted from earliest recorded date until January 2009. They identified five different types of financial incentive programs as service-requiring scholarship (41 studies), education loans with service requirements (2 studies), service-option educational loans (1 study), loan repayment programs (3 studies), and direct payment programs (5 studies). The study outcome was categorized in three groups: program results, program effects, and program impact.

Most studies showed program results outcomes of recruitment, retention, and satisfaction of participants or families. For example, in 1975, Bass and Copeman measured the outcome of Ontario Underserved program and found that about 53% completed committed services and 74% remained in the original location. In 1997 and 2007, Inoue evaluated the Jichi Medical University program, which provided medical students scholarships for exchange with serving at least nine years in rural communities. The findings showed that 96% of participants completed the contract and

67% remained in the original location. In 1994, Pathman et al. studied the outcome of National Health Service Corps (NHSC) programs. The finding showed that participants complete committed services less than non-participants do. The means satisfaction of participants (NHSC physicians) also were lower than the satisfaction of non-participants.

The financial incentives programs effect outcome composed of provision of care, retention, and participant satisfaction. Evidences showed program effect outcomes, for instance, Rabinowitz evaluated the Physician Shortage Area Program from Jefferson Medical College in Philadelphia. In 2000, Rabinowitz found that participants' physicians were two time more likely to provide care to the underserved people compared with non-participants physicians. In 2001, Rabinowitz showed that 24% of NHSC physicians provided primary care in rural areas compared with 5% of non-NHSC physicians. In 2003, Probst et al. evaluated the NHSC programs in South Carolina. The finding showed that 28% of NHSC alumni physicians served Medicaid patients more than 19% of non-NHSC alumni.

The financial incentives programs impact outcome composed of health system and health outcome. There were a few studies reported these outcomes. In 1990, Anderson and Rosenberg examined the impact of the Ontario Underservice Area Program. The study showed that physician density in the rural and remote areas in Ontario was increasing over the 30 years of the program. In 2005, Holmes evaluated the impact of NHSC physicians who graduated from 1976-1988. The study showed that the elimination of the program would affect 10% physicians decreasing in underserved locations. In 2006, Pathman et al. studied the impact of NHSC programs from physicians, nurses and physician's assistant working in all rural Health Professional Shortage Area

(HPSA) in the US in 1984. The finding showed that having the NHSC program participants increased the non-participants in underserved communities by six percent.

In 2004, Pathman et al. measured the outcome of financial incentives programs in 40 US states. The programs consisted of state service requiring scholarship, state loan service-option, state loan repayment, direct financial incentive for residents, and direct financial incentive for health professionals. As a whole, the study showed that states support-for-service programs increased physicians in underserved small and rural communities. The study found that loan payment and direct financial incentives committed physicians after graduated and had minimal penalties. On the other hand, the scholarship program committed physician early in their training and had high penalties. The study showed the best response for completing service and longer retention among participants from loan payment and direct financial incentive programs.

According to five financial incentives type described in Barnighausen and Bloom study in 2009. They can be categorized into two main groups: educational financial incentive support and multipurpose financial support. The educational financial support group included service-requiring scholarship, education loans with service requirements, service-option educational loans, and loan repayment programs. There is only direct payment program is the multipurpose financial support which provided flexibility compared with the educational financial support (Humphrey, 2009). There is rarely study of the effectiveness of direct payment programs. Although, the study of Pathman et al. in 2004 showed the study outcome of direct payment program outweighed the scholarship programs in recruitment and retention of physicians in underserved areas, current

evidence is not enough to conclude the effectiveness between the direct payment financial incentive and other incentive programs.

Gap in the Literature

The literature review shows that there is inadequate evidence regarding (i) what is the effectiveness of direct payment financial incentives in middle-income countries, and (ii) how the dentist response to the direct payment financial incentives for retaining them practice in rural and remote areas.

The research gap which have been found from the review literature and will be fulfilled from this study are including:

1. Most current studies were from developed countries, there was a few studies from developing countries. Most evidences from developed countries evaluated the outcome of the financial incentives program such as NHSC programs from USA, Ontario Underserviced Area Program from Canada, Jichi Medical University program from Japan. Many evidences from developing countries explored and identified the important of financial factors without estimating the program outcome (Adzei, 2012; Agey-Baffour, 2013; Awofeso, 2010)

2. Most current studies target population were medical students and physicians, there was a few studies target population on other health professionals including dentists. For example, among 24 NHSC evaluated programs, there is only study from Mofidi et al. in 2002 reported the retention rate of dentists who participated in NHSC programs.

3. Currently financial incentives evaluation programs mostly examined programs supported education such as scholarships and loan forgiveness programs. There

were a few studies assess direct payment programs. This is consistent with the majority of financial evaluated studies mostly conducted in developed countries. Most Developed countries implemented educational support programs such as scholarships and loan forgiveness program. For example, NHSC programs in US provide service-requiring scholarships for students and loan repayment program for physicians. Ontario Underservices Area Program in Canada provide Service-requiring scholarships for medical students and direct financial incentives for physicians. Jichi Medical University in Japan provide service-requiring scholarships for medical students.

There is no evidence of study on a high direct payment incentive (provide 1-3 times of salary) programs.

The first gap is the current published evaluated strategies for recruiting and retaining healthcare workers in rural and remote areas mostly done in developed countries (Humphrey, 2008; Wilson, 2009; Dolea, 2010; Grobler, 2015; Verma, 2016). The financial incentives programs were also mainly conducted in developed countries. Several reviewed articles showed that most of the effectiveness financial incentive programs for attracting and retaining health professional in rural and remote areas were evaluated and published by many developed countries. For example, in 2004, Sempowski reviewed 10 articles: 6 articles from US, 3 articles from Canada, 1 article from New Zealand and 1 article from South Africa. In 2009, Barnighausen and Bloom reviewed 43 articles: 34 articles from US, 5 articles from Japan, 2 articles from Canada, 1 article from Australia, and 1 article from South Africa.

Most studies of human resources for health in low-and-middle income countries explored the problems and identified the factors related with the problem (Adzei,2012;

Awofeso,2010). Although, many countries have adopted the strategies recommended by WHO, there is less studies evaluating the effectiveness of the programs (Lehmann, 2008; Henderson, 2008; Buchan, 2013; Dolea, 2010). Evidence for the effectiveness of addressing strategies is highly required especially the effectiveness of financial incentives which commonly used in low-and middle-income countries (Dolea, 2010; Grobler, 2015). The reviewed articles showed that the programs affected decision to leave or stay in rural and remote areas diversely due to the program implementation in different environments and contexts such as different occupations, different countries. These finding suggest that there is required for a study of the effectiveness of financial incentives for retaining healthcare workers in rural and remote areas in more developing countries.

The second gap is many published articles of the effectiveness of financial programs focusing on the behavior of medical students and physicians. For example, among 43 articles which were reviewed by Barnighausen and Bloom, there were 3 articles: Bradbury in 1963; Mofidi et al. in 2002; and Porterfield in 2003 that showed study outcome of dentists. In addition, among the studies examined the effectiveness of the National Health Service Corps (NHSC) programs mostly showed the results of medical students or physicians, despite students who enrolled in the NHSC programs involved family nurses, midwives, physician assistants, and dentist (Barnighhausen and Bloom, 2009). In 2003, Porterfield reported that alumni NHSC dentists were less likely to work in underserved areas compared with alumni NHSC physicians. However, this evidence is insufficient to explain the different or similar location choice behavior of physicians and dentists.

In Thailand, public/private organization distribution of dentists different from physicians, pharmacists, and nurses as shown in Table 3.8. Data showed that dentists mostly practice in private sectors compared with others health professional which dominated in public sectors. Therefore, the study of the effectiveness of financial incentives on dentists is required to test whether the dentist's location choice behavior is different from other health professionals.

Table 2.1 Public/Private organization distribution of health workers

Healthcare professionals	Public sector Number (%)	Private sector Number (%)	Total Number
Doctors	21,550 (82.1)	4,694 (17.9)	26,244
Dentists*	4,725 (47.4)	5,221 (52.6)	9,926
Dental nurses*	4,313(100)	-	4,313
Pharmacists	7,173 (82.4)	1,527 (17.6)	8,700
Nurses	122,460 (89.7)	13,987 (10.3)	136,447

Public sector: Includes all government owned/funded health facilities under health ministry and other related ministries.
Sources: MoPH, 2010
* Dental council, 2009

The third gap is most of studies evaluated financial incentives which supported education such as service-requirement scholarship or loan repayment programs. For example, among 43 articles Barnighausen and Bloom found 5 direct payment financial incentives programs from 4 articles: Bass and Copeman in 1975; Anderson and Rosenberg in 1990; Jackson in 2003; and Pathman in 2000 and 2004. The scholarship and loan repayment programs are benefit for healthcare students and professionals in some countries such as the United Stated where the educational cost is very high. However, in some countries where have low educational cost, the scholarship and loan repayment may

be less attractive than direct payment incentives. Therefore, there should be more studies evaluated the effectiveness the direct payment incentives program.

The fourth gap is no published evidence on the high direct payment incentive program. The study of Voluntary Bonding Scheme New Zealand Ministry of Health in 2012 showed the proportion of direct payment incentives to the physicians was about 10 percent of physician's salary. The direct payment program in West Virginia showed maximum incentive was US$ 20,000 to 40,000 per year for physicians working in underserved areas in 2001 (Jackson, 2003). In Thailand, the Hardship Allowance for dentists working in rural and remote areas in 2008 were US$ 3,750 – 11,250 per year. Although the payment was lower compared with incentive payment in New Zealand and US, the Hardship Allowance in 2008 was 100-200% of new dentist's salary in Thailand. This study will show the effectiveness of the high direct payment incentive for retaining dentists in rural and remote areas.

Conceptual Framework

Based on the utility theory, this study apply to create the model of Thai dentist's location choice which shown in Figure 2.2. We assumed that the Thai dentists' decision to leave or stay in rural and remote areas depend on two major factors including financial and non-financial factors.

The conceptual framework of the study is showed in Figure 2.3. This framework shows all factors related to the dentists's decision to leave or stay in rural and remote areas following the model of dentist's location choice. The framework shows two major factors including financial and non-financial factors. In this study, we aim to examine

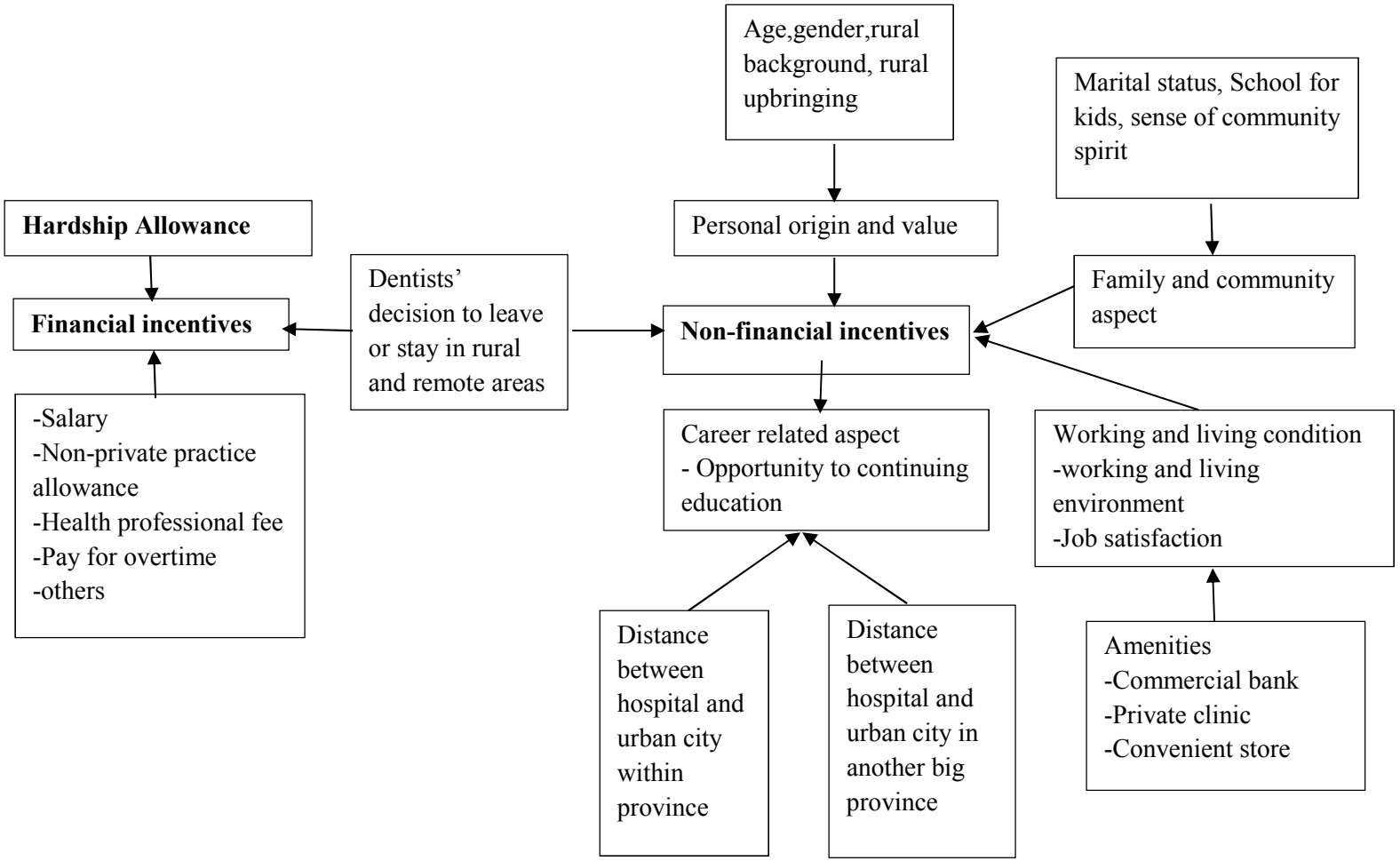

Figure 2.3 Conceptual Framework

the effectiveness of the Hardship Allowance, which is the direct payment financial incentives for dentists working in primary hospitals under the MoPH. Another box of financial incentives, which might show in the econometric model for data analysis. However, other financial incentive such as the pay for overtime which is various in each hospital may be confounding factor that related to the location choice of dentists. For non-financial incentives in this study, we examine the relationship between age (personal factor) and the location choice. Although, we assumed other factors have relationship with the dentists' location choice such as the opportunity to continuing education, the limitation of data set causes the missing of this variable in the econometric model. In addition, other non-financial incentives such as the Hospitals' administration and relationship in workplace, which vary in any office, is another unobserved factor may influence the dentists' location choice (Lexomboon, 2003). The community or the district and province environment may be another confounding factor associated with the decision of dentists' to leave or stay in rural or remote areas. For instance, the remote areas in the attractive provinces (such as Chiang Mai in the North region) may be favorable place for dentists compared with rural areas in unattractive provinces (such as Burirum in the Northeast region).

CHAPTER 3

METHODOLOGY

This chapter describes the purposes and the methodology for the study. Section 3.1 outlines the Aims and the hypotheses of the study. The theoretical models which consist of the utility model of Thai dentists' location choice are shown in Section 3.2. Section 3.3 describes the methodology of the study which consists of specific aims, hypotheses, study designs, sources of data, study population, unit of analyses, dependent variables, independent variables, explanatory variables, econometric models, and data analyses.

The objectives of the study

There are three objectives to this study. The first objective of the study is to investigate the effectiveness of direct payment financial incentives, the 'Hardship Allowance' (HA), in 2008 for reducing the resignation rates of dentists in rural and remote areas relative to urban areas. The second objectives is to investigate the effect of decreasing HA , due to the 2016 policy changing of practice location status from rural to urban area and remote to rural area, on rural and remote dentist's resignation. The last objective is to determine the relationship between dentist's resignation and dentist's age after the decreasing HA, due to the 2016 policy changing of practice location status from rural to urban area and remote to rural area.

The Specific Aims of the study are:

Aim1: To examine whether the HA payment in 2008 reduced resignation rates of dentists in rural and remote provinces relative to urban provinces.

Hypothesis1: Dentists who received higher HA after 2008 are less likely to resign in **rural** areas. The resignation rates of dentists in rural and remote provinces after 2008 are decreasing compared with the resignation rates of dentists in urban provinces.

Aim2: To estimate the effect of the HA reduction, due to recategorization in HA areas from rural to urban in December 2016, on rural and remote dentists' resignation and relocation.

Hypothesis2: Rural and remote dentists who located in the changed areas which HA was reduced in December 2016 are more likely to leave (resign and relocate) from their areas. Therefore, after 2016, the resignation and relocation of dentists in changed areas increase.

Aim3: To examine the relationship between dentists' age and dentists' resignation and relocation in changed areas after the 2016 policy implementation.

Hypothesis3: Based on the policy change in 2016, the HA area was recategorized. Consequently, the HA payment rate was decreased. Rural dentists who are older affected the HA reduction more than the younger dentists. Therefore, the older dentists are more likely to resign or relocate from their areas due to the HA reduction compared with the younger dentists.

Methodology for Specific Aim 1

Aim1: To examine whether the HA payment in 2008 reduced resignation rates of dentists in rural and remote provinces relative to urban provinces.

Hypothesis1: After the HA policy in 2008, dentists in rural and remote provinces are less likely to resign. The resignation rates in rural and remote provinces after 2008 are

decreasing compared with the resignation rates in urban provinces.

Research Design

The study design for Aim1 is a longitudinal retrospective cohort study using an observational database. This study is based on the natural intervention. The intervention is the implementation of financial incentive direct payment called "Hardship Allowance" (HA) in Thailand in 2008. The Hardship Allowance is the direct payment financial incentive for physicians, dentists, pharmacists and other health providers working in primary hospitals under the Ministry of Public Health especially in rural and remote areas. However, in this study we examine the effectiveness of the financial incentive HA on retaining dentists in rural and remote areas. The treatment group in this study is only the dentist group so there is no control group. To minimize the possibilities of selection bias, we used the retrospective observational data of dentists' location from 2003 to 2016 to examine the change of location choice before and after policy implementation. The observational data of dentists' location before and after policy implementation in 2008 contains variation in Hardship Allowance program. This variation which occurred from the independent or exogenous changes in event across time can identify the effects of Hardship Allowance on the dentists' decision to stay or leave rural and remote areas.

In this study we measure the retention rate of dentists in urban, rural and remote areas by using the resignation rate of dentists by areas and by province. The resignation rates by areas are estimated by the number of dentists who resigned divided by all exist dentists in each area: urban, rural and remote areas. In this study, the area is identified by urban, rural and remote areas. There is no official definition of rural and remote areas in Thailand. The rural and remote areas, which are identified in this study, are applied from

the MoPH identification (Appendix A). The classification of the MoPH for urban, suburban, rural and remote areas are used to determine the areas for the HA payment.

The classification of rural and remotes areas in this study do not comply with this common measure which based on population or distance between working place to the city. The characteristics of hospitals in urban, rural and remote areas under the Ministry of Public Health Notification Issue 4, shows that urban areas are the capital city in each province. The urban areas in some big provinces include the capital city and other big cities which have highly density population. The rural areas are most other districts beside the capital city, in many provinces most districts are considered the rural areas which have lower density population compared with the urban city. The remote areas are found in some provinces mostly near the border provinces. The remote areas are located the furthest from the urban city compared with rural city and have the lowest density of population. However, the density population and the distance between hospitals and urban city in rural and remote areas are various in each province.

The number of urban, rural and remote areas in each province is different depending on the size and the urbanization. In this study, the rural and urban provinces are classified by using the percentage of urban hospitals in each province. The urban hospitals are calculated by the number of hospitals in urban areas divided by all hospitals in all areas in the provinces. The percentage of urban hospitals are categorized in 4 quartiles (Q1-4). The province in quartile 1 (Q1) have 7.7-16.7% urban hospitals, in quartile 2 (Q2) have 17.6-25% urban hospitals, in quartile 3 (Q3) have 26.7-33.3% urban hospitals, in quartile 4 (Q4) have 35.3-100% urban hospitals. The provinces in Q1 indicated the most rural areas. The provinces in Q2 and Q3 are more urbanization

compared with the province in Q1. The provinces in Q4 are considered the most urbanized areas.

The overall resignation rate of dentists is calculated by the number of resignation dentists divided by the number of all public dentists under the MoPH in each province. The number of resignation dentists from 2003 to 2016 are obtained from the Human Resource Management Department, MoPH. However, there is no data of individual dentists from 2003 to 2012. The updated data of individual dentists which obtained from the annual report of Policy and Strategy Bureau MoPH, are available from 2013. Therefore, the number of all dentists in each province each year since 2003 to 2012 must be retrieved from the individual dentist's data in 2013. The number of all dentists in each province from 2003 to 2012 are estimated by using the recruiting year and resigning year from individual dentist's data in 2013. The condition used to estimate active dentists is that "if dentists were active in a given year the recruiting date was before, and resignation rate was after the given year. For example, the number of active dentists in 2003 are calculated by counting all dentists who recruited before 2003 and resigned after 2003

Source of data

Our data sources for addressing the specific Aim 1 include the resignation data of public dentists under MoPH from 2003 to 2016, individual dentists' data under MoPH from 2013 to 2016, and the urban, rural and remote areas data in 2008. The resignation data are obtained from the Human Resource Management Division, Permanent Secretary Bureau, MoPH. Individual dentists' data are obtained from the Policy and Strategy Bureau, which adjusted from annual reported data of Human Resource Management Division, Permanent Secretary Bureau, MoPH. The urban, rural

and remote areas data in each province are obtained from the notification of the MoPH issue # 4 of Policy and Strategy Bureau, MoPH (Appendix A). Due to the resignation data contained only the individual dentist who resigned from primary hospitals under MoPH from 2003 to 2016. The updated individual dentists' data which obtain from the Policy and Strategy Bureau, MoPH contained exist individual dentists' data since 2013. Therefore, the existed individual dentists' data from 2003 to 2012 could be extracted from the individual dentists' data in 2013 by using recruiting year and resigning year of individual dentists as describing above.

Study population

The study population in this Aim 1 is all dentists who are the government employee working in health facilities under the MoPH. The total 3,132 resignation dentists in this study are the dentists who worked in health facilities under the MoPH and resigned from the health facilities under the MoPH from 2003 to 2016. In 2016, the total dentists who work in health facilities under the MoPH were 5,247. The study population in this aim is measured by province. The dentists' data from 75 provinces except Bangkok are used. We excluded Bangkok due to Bangkok has the special administrative jurisdiction which differently from other 75 provinces. The most important reason is no community hospitals in Bangkok which means no HA payment. Based on the reason of resignation, the dentists who retired, died or fired from any reason are excluded from the study. The dentist who work in administrative facilities such as provincial public health office and dentists who work in dental college (dental hygiene's school) are also excluded from the study.

Unit of analysis

The unit of analysis in this Aim is the province-year in Thailand. Seventy-five provinces are reported in the study excluding Bangkok.

Dependent variable

The dependent variable for Aim 1 is the resignation rate of dentists who worked in the health facilities under the Ministry of Public Health during 2003 to 2016. The dentists' resignation rate is calculated from the number of resigned dentists divided by the number of active dentists in each province in each year from 2003 to 2016. In the econometric model 1.1, the outcome variables are the resignation rate in urban, the resignation rate in rural and the resignation rate in remote areas. The rural resignation rate is calculated from the number of rural dentists who resigned from MoPH divided by the rural active dentists by province by year from 2003 to 2016. The remote resignation rate is calculated from the number of remote dentists who resigned from MoPH divided by the remote active dentists by province by year from 2003 to 2016. The urban resignation rate is calculated from the number of urban dentists who resigned from MoPH divided by the urban active dentists by province by year from 2003 to 2016.

In the econometric model 1.2, the outcome variable is the overall resignation rate in each province each year. The overall resignation rate in this model measure the effect of policy implementation of dentists' resignation in rural and remote areas compared with in urban areas.

Key explanatory variable

The key explanatory variable for Aim 1 is the HA payment policy implementation in 2008. The HA payment policy implementation in 2008 is the direct payment financial

incentives which the government provide to the healthcare provider including dentists working in community hospitals under the MoPH. The objective of the HA payment in 2008 is to attract dentists practicing in community hospitals especially in rural and remote areas by providing about 5 times of previous rate. The HA payment criteria is based on areas and year of service as shown in Table 1.1 and 1.2 for HA payment before and after 2008, respectively. The major variables in the Econometric model for Aim 1 are composed of:

Rural1 is the province in Q1 which has the urban hospital 7.7-16.7% which mean about 92.3-83.8% of the areas in the province are rural and remote hospitals.

Rural2 is the province in Q2 which has the urban hospital 17.6-25% which mean about 82.4-75% of the area in this province are rural and remote hospitals.

Urban1 is the province in Q3 which has the urban hospital 26.3-33.3% which mean about 73.7-66.7% of the area in this province are rural and remote hospitals.

Urban2 is the province in Q4 which has the urban hospital 35.3-100% which did not show in the model because being used as a reference.

Post is the HA policy implementation, post is equal 1 if in a year after 2008, otherwise post is equal zero

Post * Rural1 is the interaction of HA policy and the province in Q1, before 2008 post*rural1 is equal zero

Post * Rural2 is the interaction of HA policy and the province in Q2, before 2008 post*rural2 is equal zero

Post * Urban1 is the interaction of HA policy and the province in Q3, before 2008 post*urban1 is equal zero

Analysis Method

To achieve the first Aim, a univariate analysis provides estimates of the demographic characteristics of the study population. A bivariate analysis is conducted to determine if there is any difference in these characteristics between the rural and remote, and urban population. As well as the difference in these characteristics between before and after 2008. Mantel-Haenszel chi square test is used to determine if there are any differences between two population of rural and remote, and urban areas, and between populations before and after 2008. The analysis is conducted at a 95% confidence interval (alpha = .05) A difference in difference regression analysis is then used to estimate the differences in resignation rate in rural and remote areas relative to urban areas before and after the 2008 implemented policy. Due to data set in this study is a longitudinal data (cross-sectional time-series data) so the fixed effect for panel data analysis is used to examine the model. The model in this analysis is:

Econometric Model: Regression model using fixed effect estimation

$$\mathbf{R_{ita} = \alpha_0 + \alpha_1 post_{it} + \mu_i + \varepsilon_{it}} \quad \textbf{(1)}$$

where

$\mathbf{R_{ita}}$ is the resignation rate of dentists locate in province 'i' in year 't' in areas 'a' (urban, rural, remote areas)

post is the HA implemented policy, post = 1 if year >= 2008, otherwise post = 0

$\boldsymbol{\mu_i}$ is the province i to n.

$\boldsymbol{\varepsilon_{it}}$ is the random error term

The percentage of urban hospitals is classified into 4. The 2nd model can provide the outcome of overall resignation rate in rural-urban provinces after the policy in 2008.

The first econometric model measured the difference of the resignation rate of dentists in each area: urban, rural, and remote areas. Based on the data set using in this model is the panel data set, therefore the regression for panel data analysis is used. The outcomes of the model regression in each area will be compared and discussed. Besides the first model, we measured the outcome of the overall resignation rate of dentists in different areas before and after the policy implementation by using the econometric model equation #2. In this model the major predictors are the post (HA implementation policy) and the percentage of urban hospitals in each province. The urban hospitals are calculated and divided with all hospitals under the MoPH in each province. The percentage of urban hospitals is classified into 4 quartiles (Q1-4). The provinces in Q1 which have 7.7-16.7% urban hospitals are indicated the most rural province while the provinces in Q4 which have 35.3-100% urban hospitals are indicated the most urbanized province. The 2nd model can provide the outcome of overall resignation rate in both rural and urban provinces after the policy in 2008.

$$\mathbf{Y_{it} = \beta_0 + \beta_1 Rural1_{it} + \beta_2 Rural2_{it} + \beta_3 Urban1_{it} + \beta_4 post_{it} + \beta_5 post.\ Rural1_{it} + \beta_6 post.\ Rural2_{it} + \beta_7 post.Urban1_{it} + \varepsilon_{it}} \quad \mathbf{(2)}$$

where

$\mathbf{Y_{it}}$ is the overall resignation rate of dentists in province'i' in year 't'

Rural1 is the province in Q1 with the lowest percentage of urban hospitals, Rural1= 1 if urban hospital = 7.7-16.7%, otherwise Rural1=0

Rural2 is the province in Q2 with the lower percentage urban hospitals, Rural2= 1 if urban hospital = 17.6-25%, otherwiseRural2=0

Urban1 is the province Q3 with the moderate percentage of urban hospitals, Urban1= 1 if urban hospital = 73.7-66.7%, otherwise Urban1=0

Urban2 is the province in Q4 with the highest urban hospital which did not show in the model because being used as a reference.

post is the HA implemented policy, post = 1 if year >= 2008, otherwise post = 0

ε_{it} is random error

Methodology for Specific Aim 2

Aim2: To estimate the effect of the HA reduction, due to recategorization in HA areas from rural to urban in December 2016, on rural and remote dentists' resignation and relocation.

Hypothesis2: Rural and remote dentists who located in the changed areas which HA was reduced in December 2016 are more likely to leave (resign and relocate) from their areas. Therefore, after 2016, the resignation and relocation of dentists in changed areas increase.

Research design

The study design for Aim 2 is a longitudinal retrospective cohort study using an observational data. The study is based on the natural intervention. The intervention is the implementation of reducing the Hardship Allowance rate by changing the dentist's working location categorization for allocating HA in Thailand in December 2016. The Hardship Allowance is the direct payment financial incentive for physicians, dentists, pharmacists and other health providers working in primary hospitals under the Ministry of Public Health especially in rural and remote areas. In 2008, Thai government have launched a policy for attracting healthcare providers stay longer in rural and remote areas by providing direct payment financial incentive called "Hardship Allowance".

In 2008, the HA in rural areas was about 100% of new graduated dentists' salary and in remote areas at 200-300%. After the economic growth and urbanized expansion, in December 2016 the government adjusted the HA area categorization. Some rural areas became urban areas causing the reduction of the HA rate on the changed areas. The adjusted HA areas categorization criteria are followed the Notification of MoPH on December 2012. It was identified that all area in each province were reclassified the urban, rural or remote areas based on these criteria. First criteria is the difficulty of transportation from the working location to the urban city within province and to another big provinces nearby. Second one is the urbanization within the working area's district such as number of commercial banks, number of medical and dental private clinics, number of convenient stores, annual revenue of local government in district level, etc. Third one is the dentist shortage situation in that area. And the last one is the areas are in the risk zone which are the three provinces in southern border of Thailand.

The adjusted working areas are collected and distributed by the Ministry of Public Health Notification Issue #11 and the list of new areas after changing in December 2016 are shown in Appendix B. In this study we examine the effect of the financial incentive HA reduction due to the adjusting HA area categorization in some rural areas on dentists' retention in rural and remote areas. The policy affects all dentist population in the study. The treatment group in this study is only the dentist group so there is no control group. To minimize the possibilities of selection bias, we used the retrospective observational data of dentists' location from 2013 to 2018 to examine the change of location choice before and after policy implementation in December 2016. The observational data of dentists' location before and after policy implementation in December 2016 contains

variation in Hardship Allowance reduction program. This variation which occurred from the independent or exogenous changes in event across time can identify the effects of Hardship Allowance reduction on the dentists' decision to leave or stay in rural and remote areas.

In this study we measure the retention rate of rural and remote dentists who stay or leave from their practice location after the recategorized HA areas from rural areas to urban areas by using the resignation and relocation of rural and remote dentists. We compared the resignation and relocation of dentists between the changed areas and unchanged areas to show the characteristics of dentists in these two areas. Due to the data set we obtained is the longitudinal data of individual dentists from 2013 to 2018 so we can do the panel data analysis. We estimate the resignation and relocation of rural and remote dentists in the changed areas and unchanged areas after the policy implementation in December 2016 by using difference in difference regression with fixed effect estimation for panel data analysis.

Sources of data

Data sources used for addressing this specific Aim 2 included the dentists' data from 2013 to 2018, and the rural and remote areas data adjusted in December 2016. The dentist data obtained from the Policy and Strategy Bureau, which is revised from annual reported data of Human Resource Management Division, Permanent Secretary Bureau, MoPH from 2013 to 2018. The data contained of individual dentist's data in each year from 2013 to 2018. Initially, data of dentists in 2013 was selected only dentists located in rural and remote areas. The new recruited dentists in 2014, 2015, and 2016 were also located in rural and remote areas. The individual dentist data include dentists'

characteristics for example gender, age, year of service, current salary, and specialty and geographic location of each dentists by year. The changed status of rural to urban areas data is obtained from the notification of the MoPH issue # 11,12 by the Policy and Strategy Bureau, MoPH in December 2016 (Appendix B).

Study population

The study population in this Aim 2 is all dentists who work as a government employee in rural and remote primary hospitals under MoPH across the country during 2013 to 2018. In this study we excluded data of rural and remote dentist who is identified that died or retired or was fired from any reason.

Unit of analysis

The unit of analysis in this study is the individual dentist-year working in rural and remote primary hospitals under MoPH from 2013 to 2018.

Dependent variable

To achieve Aim 2, the dependent variable is whether an individual dentist who working in rural and remote primary hospitals under the Ministry of Public Health **resign or relocate (to urban areas)** from their location during 2013 to 2018.

Key explanatory variable

The key explanatory variable for Aim 2 are the time that changed HA areas implementation in December 2016 and the changed areas. The changed HA areas policy in December 2016 is implemented in some rural areas. These rural areas became urban areas in December 2016, as a result the HA payment rate reduced. The objective of the HA areas recategorization in December 2016 is to adjust the areas to comply with the economics and urban expansion. The HA payment rate and criteria in

December 2016 is as same as in 2013 as shown in Table 3. The major variables in the Econometric model for Aim 2 are composed of:

RuraltoUrban is the changed areas, ruraltourban =1 if the rural areas became in urban areas in December 2016, otherwise ruraltourban=0

Post in the econometric model identified when the time of policy implementation in December 2016, after December 2016 post = 1, otherwise = 0.

Post * RuraltoUrban is the interaction of the policy implementation in December 2016 and the changed area, if after December 2016 and in the changed area, post*ruraltourban is = 1, otherwise = 0

Covariate variables

The covariate variables use to accomplish Aim 2 are following these variables:

Age is recorded in number in data set. Age of dentists' data set is the current age at the time data was record. Age will be categorized in 4 groups: 1 = age 23-28 years, 2 = age 29-35 years, 3 = age 36-45 years, 4 = 46-60 years

Gender of rural and remote dentists is recorded in text in data set. Two value of dentists' gender is recorded for male and female.

Year of service is recorded in number in data set. Year of services is the duration that dentists working in any rural and remote primary hospitals under the MoPH. It is calculated from the different of recruitment date which is a date when dentist start working in MoPH and resignation date which is a date when dentist quit working in MoPH.

Region is the geographic area. In Thailand is divided into 4 regions: 1=Northern region, 2=Central region, 3=Northeastern region, and 4=Southern region.

Distance is the distance from the dentist's practice location (primary hospital) to the urban city in each province. The distance in this study is measured in kilometer (1 kilometer = 0.62 mile). In the econometric model for Aim 2 the distance is categorized in 4 groups: 1=0-20km., 2=21-40km.,3=41-60km., and 4=61km.ups

Analysis method

To describe and understand the overview of data in Aim 2, a univariate analysis is computed to summarize the characteristics of the study population. A bivariate analysis is used to demonstrate whether there is any difference between before and after December 2016. Mantel-Haenszel chi square test is conducted to measure if there are any differences in these characteristics between before and after December 2016. The analysis is conducted at a 95% confidence interval (alpha =.05). The objective of a bivariate analysis is to control for the unbiased selection. This can show the variation among the population in these two group to identify the effects of the recategorizing HA areas policy on the rural and remote dentist's decision to resign or relocate to urban.

A difference in difference regression analysis with fixed effect estimation for panel data is then used to estimate the differences in rural and remote dentist's resignation and relocation in changed areas after December 2016 implemented policy.

Econometric Model: Difference in difference regression model using fixed effect estimation

$$Y_{it} = \beta_0 + \beta_1 \text{ruraltourban}_{it} + \beta_2 \text{post}_{it} + \beta_3 \text{post}_{it}.\text{ruraltourban}_{it} + \beta_m X_{it} + \varepsilon_{it}$$

Where

Y_{it} is the outcome variables including:

1) Y_{it} is whether dentist 'i' **resigned** in year 't' , Y_{it} = 1 if dentist 'i' resigned in 't', otherwise Y_{it} = 0 ;
2) Y_{it} is whether dentist 'i' **relocate** to urban in year 't' , Y_{it} = 1 if dentist 'i' relocate to urban in 't', otherwise Y_{it} = 0 ;
3) Y_{it} is whether dentist 'i' **resigned &relocate** in year 't' , Y_{it} = 1 if dentist 'i' resigned and relocate in 't', otherwise Y_{it} = 0 $_t$

$Ruraltourban_{it}$ is the changed areas, ruraltourban =1 if the rural areas became in urban areas in December 2016, otherwise ruraltourban=0

$Post_t$ is the policy implementation, post = 1 if year >= 2017, otherwise post = 0

$Post.ruraltourban_{it}$ is the time after policy implementation interaction with the changing area status areas in year 't'

X_{it} is covariate variables

β_0 is the intercept

β_1 is the slope coefficient for ruraltourban, if β_1 is positive, means where the area is changed, the dentist is more likely to resign from the area. If β_1 is negative, means that where the area is changed, the dentist is less likely to resign from the area, holding other variable constant.

β_2 is the slope coefficient for policy implementation in 2017, if β_2 is positive, means that when the policy implemented in 2017, the dentist is more likely to resign from the area. If β_2 is negative means that when the policy implemented in 2017, the dentist is less likely to resign from the area, holding other variable constant.

β_3 is the slope coefficient for interaction of policy implementation and the changed area, β_3 is the probability of dentist's resignation after the policy change and the changed area.

If β_3 is positive, it means that after December 2016 at the changed area the dentist is more likely to resign. If β_3 is negative, it means that after December 2016 at the changed area the dentist is less likely to resign, holding other variables constant.

β_m is the slope coefficient for covariate variables and the probability of dentist's resignation by covariate variables, holding other variables constant.

Methodology for Specific Aim 3

Aim3: To examine the relationship between dentists' age and dentists' resignation and relocation in changed areas after the 2016 policy implementation.

Hypothesis3: Based on the policy change in 2016, the HA area was recategorized. Consequently, the HA payment rate was decreased. Rural dentists who are older affected the HA reduction more than the younger dentists. Therefore, the older dentists are more likely to resign or relocate from their areas due to the HA reduction compared with the younger dentists.

Research design

The study design for Aim 3 is also a longitudinal retrospective cohort study using an observational data. The study is based on the natural intervention. The intervention is the implementation of reducing the Hardship Allowance rate by changing the dentist's working location categorization for allocating HA in Thailand in December 2016. The Hardship Allowance is the direct payment financial incentive for physicians, dentists, pharmacists and other health providers working in primary hospitals under the Ministry of Public Health especially in rural and remote areas. In 2008, Thai government have launched a policy for attracting healthcare providers stay longer in rural and remote areas by providing direct payment financial incentive called "Hardship Allowance".

In 2008, the HA in rural areas was about 100% of new graduated dentists' salary and 200-300% in remote areas. After the economic growth and urbanized expansion, in December 2016 the government adjusting the HA area categorization. Some rural areas became urban areas causing the reduction of the HA rate on that area. The adjusting HA area categorization criteria are followed the Notification of MoPH on December 2012. It was identified that all area in each province were reclassification for the urban, rural or remote areas based on several criteria following these. First is the difficulty of transportation from the working location to the urban city within province and to another big province nearby. Second is the urbanization within the working area's district such as number of commercial banks, number of medical and dental private clinic, number of convenient stores, annual revenue of local government in district level, etc. Third is the dentist shortage situation in that area. The last one is the areas are in the risk zone which are the three provinces in southern border of Thailand.

The adjusting working areas are collected and distributed by the Ministry of Public Health Notification Issue 11 and the list of new areas after changing in December 2016 is shown in Appendix B. In this study, we investigate the relationship between dentists' retention and dentists' age after influencing by the financial incentive HA reduction due to the adjusting HA area categorization in some rural areas. The policy affects all dentist population in the study. The treatment group in this study is only the dentist group so there is no control group. To minimize the possibilities of selection bias, we used the retrospective observational data of dentists' location from 2013 to 2018 to examine the change of location choice before and after policy implementation in 2017. The observational data of dentists' location before and after policy implementation in

2017 contains variation in Hardship Allowance reduction program. This variation, which occurred from the independent or exogenous changes in event across time, can identify the effects of Hardship Allowance reduction on the dentists' resignation in relation to the dentists' age.

In this study, we measure the relationship of the age and the resignation rate of rural and remote dentists after the adjusting areas policy from rural areas to urban areas in December 2016. We compared the resignation dentists in each age group (22-28, 29-35, 36-45, 46-60) between the changing areas and unchanging areas to show the characteristics of dentists in these two areas. Due to the data set we obtained is the longitudinal data of individual dentists from 2013 to 2018 so we can do the panel data analysis. We estimate the resignation rural and remote dentists in each age group in the changing areas and unchanging areas after the policy implementation in December 2016 by using segmented regression for panel data analyzation.

Sources of data

Data sources used for addressing this specific Aim 3 is as same as data used in Aim2, which included the data of dentists from 2013 to 2018, and the rural and remote areas data adjusted in December 2016. The data of dentist obtained from the Policy and Strategy Bureau, which is revised from annual reported data of Human Resource Management Division, Permanent Secretary Bureau, MoPH from 2013 to 2018. The data contained of data of individual dentists in each year from 2013 to 2018. The individual dentist data include dentists' characteristics for example gender, age, year of service, current salary, and specialty and geographic location of each dentists by year. The changing status of rural areas to urban areas data is obtained from the notification of

the MoPH issue # 11,12 by the Policy and Strategy

Bureau, MoPH in December 2016 (Appendix B).

Study population

The study population in this Aim 3 is all dentists who work as a government employee in rural and remote healthcare facilities under MoPH across the country during 2013 to 2018. In this study we exclude data of rural and remote dentist who is identified in the resignation reason that died or retired or was fired from any reason.

Unit of analysis

The unit of analysis in this study is the individual dentist-year working in healthcare facilities under MoPH from 2013 to 2018.

Dependent variable

To achieve Aim 3, the dependent variable is whether an individual dentist who working in rural and remote primary hospitals under the Ministry of Public Health **resign** from their location from 2013 to 2018.

Key explanatory variable

The key explanatory variable for Aim 3 are the implementation of the changing practice location categorization in December 2016, the changing areas and dentists age. In this study, we aim to measure the relationship of dentists' resignation and age in changing areas after the policy implementation. The HA areas changing policy in December 2016 is implemented in some rural areas which become urbanized. Some rural areas became urban areas in December 2016 as a result the HA payment rate reduced. The objective of the HA areas change implementation in December 2016 is to adjust the areas to comply with the economics and urban expansion. The HA payment criteria in

December 2016 is as same as the payment criteria in 2013 as shown in Table 3. The major variables in the Econometric model for Aim 2 are composed of:

The major variables in the Econometric model for Aim 2 are composed of:

RuraltoUrban is the changed areas, ruraltourban =1 if the rural areas became in urban areas in December 2016, otherwise ruraltourban=0

Post in the econometric model identified when the implementation of the changing practice location status in December 2016, after December 2016 post = 1, otherwise = 0

Age is recorded in number in data set. Age of dentists data is the current age at the time data recorded the MoPH. Age will be categorized in 4 groups: 1 = age 23-28 years, 2 = age 29-35 years, 3 = age 36-45 years, 4 = 46-60 years.

Post * RuraltoUrban is the interaction of the policy implementation in December 2016 and the changed area, if after December 2016 and in the changed area, post*ruraltourban is = 1, otherwise = 0

RuraltoUrban*Age is the interaction of the changing area status from rural to urban areas and dentists' age

Post *RuraltoUrban*Age is the interaction term of the time implementation of the changing practice location status in 2016, the changed area and age, we can see how age affect the dentist's resignation and relocation in changed areas after the time of the HA areas recategorization implementation in December 2016 .

Covariate variables

The covariate variables use to accomplish Aim 2 are following these variables:

Gender of rural and remote dentists is record in text in data set. Two value of dentists' gender is recorded for male and female.

Year of service is recorded in number in data set. Year of services is the duration that dentists working in any rural and remote primary hospitals under the MoPH. It is calculated from the different of recruitment date which is a date when dentist start working in MoPH and resignation date which is a date when dentist quit working in MoPH.

Region is the geographic area. In Thailand is divided into 4 regions: 1=Northern region, 2=Central region, 3=Northeastern region, and 4=Southern region.

Distance is the distance from the dentist's practice location (primary hospital) to the urban city in each province. The distance in this study is measured in kilometer (1 kilometer = 0.62 mile). In the econometric model for Aim 2 the distance is categorized in 4 groups: 1=0-20km., 2=21-40km.,3=41-60km., and 4=61km.ups

Analysis method

To describe and understand the overview of data in Aim 3, a univariate analysis is computed to summarize the characteristics of the study population. A bivariate analysis is used to demonstrate whether there is any difference between the rural and remote population by age. In addition, the difference in these characteristics between before and after 2016 by age. Mantel-Haenszel chi square test is conducted to measure if there are any differences between the rural population and remote population as well as the differences in these characteristics between before and after 2016 by age. The analysis is conducted at a 95% confidence interval (alpha =.05). The objective of a bivariate analysis is to control for the unbiased selection. This can show the variation among the population in these two group to identify the effects of the changing policy and age on the dentist's decision to resign.

A triple differences regression analysis with random effect estimation for panel data is then used to estimate the differences in rural and remote dentist's resignation and relocation in relation to dentists' age where the area is changed after the December 2016 policy implementation.

Econometric Model: triple differences regression model using random effect estimation

$Y_{it} = \beta_0+\beta_1 ruraltourban_{it} + \beta_2 age_{it}+ \beta_3 post_{it}+ \beta_4 post.ruraltourban_{it} + \beta_5\, post.age_{it}+ \beta_6 ruraltourban_{it}.age_{it} + \beta_7\, post.ruraltourban_{it}.age_{it} +\beta_m X_{it} + \varepsilon_{it}$

Where Y_{it} is the outcome variables including:

1) Y_{it} is whether dentist 'i' **resigned** in year 't' , $Y_{it} = 1$ if dentist 'i' resigned in 't', otherwise $Y_{it} = 0$;
2) Y_{it} is whether dentist 'i' **relocate** to urban in year 't' , $Y_{it} = 1$ if dentist 'i' relocate to urban in 't', otherwise $Y_{it} = 0$;
3) Y_{it} is whether dentist 'i' **resigned &relocate** in year 't' , $Y_{it} = 1$ if dentist 'i' resigned and relocate in 't', otherwise $Y_{it} = 0_t$

$Ruraltourban_{it}$ is the changed areas, ruraltourban =1 if the rural areas became in urban areas in December 2016, otherwise ruraltourban=0

Age_{it} is the dentist 'i' age in year't', age is categorized in 4 groups: 1 = age 23-28 years, 2 = age 29-35 years, 3 = age 36-45 years, 4 = 46-60 years

$Post_{it}$ is the areas changing implemented policy, post = 1 if year >= 2017, otherwise post = 0

$Post.ruraltourban_{it}$ is the time after policy implementation interaction with the changing status areas in year 't'

$Post.age_{it}$ is the time after policy implementation interaction with the age of dentist 'i' in year 't'

$ruraltourban_{it}.age$ is the changed areas in year 't'interaction with the age of dentist 'i' in year 't'

$Post.ruraltourban_{it}.age_{it}$ is the time after policy implementation interaction with the changing status areas in year 't' interact with the age of dentis 'i' in year 't'

X_{it} is covariate variables

β_0 is the intercept

β_1 is the slope coefficient for ruraltourban, if β_1 is positive, means that where the area is changed, the dentist is more likely to resign from the area. If β_1 is negative, means that where area is changed, the dentist is less likely to resign from the area, holding other variable constant.

β_2 is the slope coefficient for age group. It is the percent of change in dentist's 'i' resignation among age group.

β_3 is the slope coefficient for the time implementation in December 2016, if β_3 is positive, means that when the policy implemented in December 2016, the dentist is more likely to resign from the area. If β_3 is negative, means the dentist is less likely to resign from the area, holding other variable constant.

β_4 is the slope coefficient for interaction of the time policy implementation in December 2016 and the changed area, β_4 is the probability of dentist's resignation and relocation after the policy implementation and the changed area, holding other variables constant.

β_5 is the slope coefficient for interaction of the time policy implementation and age, β_5 is the probability of dentist's resignation and relocation after the time policy implementation in December 2016 among age groups, holding other variables constant.

β_6 is the slope coefficient for interaction of changed area status and age group, β_6 is the probability of dentist's resignation and relocation where the area is changed among age groups, holding other variables constant.

B_7 is the slope coefficient for interaction of the time policy implementation in December 2016, the changed area, and age group, β_7 is the probability of dentist's resignation and relocation after the time policy implementation in December 2016 where the area is changed among age groups, holding other variables constant.

β_m is the slope coefficient for covariate variables. β_m is the probability of dentist's resignation and relocation by covariate variables, holding other variables constant.

CHAPTER 4

MANUSCRIPT 1

THE EFFECTIVENESS OF DIRECT PAYMENT FINANCIAL INCENTIVE ON REDUCING RESIGNATION RATE OF DENTISTS IN RURAL AND REMOTE AREAS: EVIDENCE FROM THAILAND[1]

[1] Noochpoung R., Hair N., Hung P., Puttrasri W., Chen B., to be submitted to BMD Health Service Research

Abstract

Financial incentive is one of the common strategies used to attract healthcare workers to and retain them in rural and remote areas by many policy makers in developed and developing countries. Current studies show that most of the financial incentives supported education such as scholarships and loan repayment programs are effective. Few studies assessed the effectiveness of direct payment incentive programs, especially in low-middle income countries. This study aims to examine the effectiveness of direct payment (Hardship Allowance) on retaining dentists in rural and remote areas using data from Thailand. A retrospective observational study was conducted. Data on the resignation of dentists from 2003 to 2016 and an annual report on dentist's location were obtained from the Human Resource Management and the Policy and Strategy Bureau, Ministry of Public Health (MoPH) in Thailand. The difference in difference regression and the fixed effect estimation were used to analyze the effectiveness of Hardship Allowance implemented in 2008. Data from 2003 to 2016 showed that 2,351 dentists who resigned from the hospital under the MoPH. Over 60% of resigned dentists were between 22-28 years old. The resignation rate from 2003 to 2016 showed that dentists who were located in rural areas had the highest rate compared with dentists in urban and remote areas. The highest resignation rate in rural areas in 2004 was at 29.4%. When the Hardship Allowance policy was implemented in 2008, the resignation rate started decreasing dramatically in all areas, but especially in rural areas. Additionally, the regression analysis showed that the resignation rate of dentists in rural areas significantly decreased after 2008 by 9.94% (p-value <0.001), while in urban areas after 2008 the resignation rate decreased by only 2.12% (p-value <0.001).

In conclusion, the study showed that after the policy implementation the resignation rate of dentists decreased in all areas. When comparing the resignation rate in rural and urban areas, the resignation rate in rural areas decreased higher than in urban areas after 2008. Therefore, the Hardship Allowance programs could retain dentists in rural and remote areas in Thailand.

Introduction

The uneven distribution of the healthcare workforce between urban and rural areas is a global issue (WHO, 2010). The statistics showed that 24% of health providers are in rural areas, while 50% of the world population live in rural areas (WHO, 2010). This maldistribution of healthcare workers happens both in developed and developing countries. For example, in the United States, 20% of the population lives in rural areas, but only 9% of physicians are located there (Hancock et al., 2009). In the urban areas of Canada and Australia, there are approximately 2.6 and 4.0 physicians per 1000 people, respectively, while in rural areas of both countries, there are 0.9 physicians per 1000 people (Viscomi, 2013). Evidence showed the maldistribution of health workers in developing countries is much more severe. For example, in Vietnam at least 53% of physicians are located in urban areas while 72% of Vietnamese people live in rural areas. Moreover, data showed that only 67% of rural health centers in Vietnam have a physician (Vujicic, 2011). Similarly, in Cambodia, approximately 54% of physicians served in the capital city, even though only 9.6% of Cambodians reside in Phnom Penh. In 2005, the physician density in the urban areas was about 0.41 per 1000 Cambodian population, while in the most remote areas the density of physicians was only 0.06 per 1000 population (Chhea, 2010). Thailand is also one of the countries in Southeast Asia, which

confronts the maldistribution of healthcare workers in urban and rural areas (Wibunpolprasert, 2003).

Dental care is a part of healthcare that experiences short supply in rural and remote areas as well as the issues described above. The maldistribution between urban and rural dentists also exists, and there are a few studies that report the unequal dental supply. Research showed that about 20% of California communities have a shortage of dentists. Approximately 70% of communities with dental supply shortages are rural. Areas with a lower supply of dentists have higher percentages of minorities, children, and low-income populations (Mertz, 2001). In Australia, a study showed that dentists in a major city were 59.1 per 100,000 population, while in rural and remote areas dentists were 28.3 and 16.0 per 100000 population (Teusner, 2005). In Thailand, dentists are also inequitably distributed, with shortages in some rural and remote areas. Data from the Ministry of Public Health (MOPH) reported in 2013 shows 50.9% of dentists are in Bangkok and other big cities, while 49.1% of dentists served population in all countries in four regions: in North, Central, Northeast, and South region (Dental department MoPH, 2005).

Oral healthcare is an important aspect of overall healthcare. Evidence showed the uneven distribution of dental supply related with the disparity in dentalcare access among people in Bangkok and other regions (Lapying & Puttasri, 2013; 2014). The statistics showed the dentist per population ratio in Bangkok in 2005 and 2013 was 1:1,305 and 1:1,039, respectively. In 2013, it was 1:9,147, 1:8,499, 1:9,300, and 1:13,783, respectively in the North, Central, South, and Northeast regions. Data showed that Bangkok, which has higher supply of dentists, also presented higher dental care access.

For example, in 2003, 2007, and 2011 the dental service utilization rate was at 0.28, 0.21, and 0.27 visit/person/year, respectively. In contrast, in the Northeastern region, which has the lowest supply of dental care, the dental care utilization rate was at 0.12 in 2003, 2007, and 2011.

Nevertheless, this type of disparity distribution is problematic, attempts have been made to address it. Several interventions were recommended by World Health Organization (WHO) in 2010 to lessen the inequitable distribution of healthcare workers. WHO (2010) established the framework of factors related to healthcare workers' decision to leaving or staying in rural and remote areas. The factors include financial aspect, personal and family factors, working and living conditions, career aspects and mandatory service factors. To simplify all related factors in our study, we consider other factors besides financial factors as non-financial factors.

The non-financial incentives can include educational support or general support, and they are generally used to solve the shortage of healthcare workers in rural and remote areas in developed and developing countries (Barnighausen and Bloom, 2009; Dolea, 2010). Non-financial incentives include educational strategies, mandatory service strategies, and professional and personal support strategies (WHO, 2010). Several studies support using both financial and non-financial incentives to recruit and retain healthcare workers in rural and remote areas (Wibulpolprasert, 2003; Henderson, 2008; Dolea,2010; Grobler, 2015). Nevertheless, financial incentives intervention is more likely to be used by many policy makers when facing a shortage of healthcare workers despite having insufficient evidence of the effectiveness of financial incentives (Dolea, 2010). In fact, evidence showed the financial incentive affected recruitment more than retention

(Barnighausen and Bloom, 2009; Hamphrey, 2009). The financial incentive strategies are still used by many countries, and the evaluation of the effectiveness of the programs is still needed (Dolea, 2010; Globler,2015).

Financial incentives strategy is the common approach that many countries used to reduce the healthcare providers maldistribution (WHO,2010; Dolea, 2010). Barnighausen and Bloom (2009) reviewed articles which reported the effectiveness of the financial incentives' programs. Most studies have been done in developed countries. Among the 43 reviewed articles in Barnighausen and Bloom (2009), 34 studies were from the US, 5 were from Japan, 2 were from Canada, 1 was from Australia, and 1 was from South Africa. Financial incentives can be categorized into 5 programs: service-requiring scholar, education loans with service requirements, service option educational loans, loan repayment, and direct-payment program (Barnighausen and Bloom, 2009). Moreover, the financial incentives could be classified into 2 groups: educational-support and the general-support based on the purpose of payment. All 43 articles reported the effectiveness of health workers' recruitment, while only 18 articles reported the effectiveness of the health workers retention in rural and remote areas. Most studies evaluated the educational support programs. For example, among the 34 articles from the US, 24 studies reported the effectiveness of National Health Service Corps (NHSC) program, which provides scholarships and loan repayment for healthcare students and young healthcare professionals in exchange for working in underserved areas.

Although, the NHSC participants included physicians, nurses, dentists, pharmacists, and other health providers, most studies measured the recruitment and retention of medical students and physicians. Among the NHSC evaluated studies, only

Mofidi (2002) measured the effectiveness of financial incentives for NHSC dentists. In addition, all study's participants from Canada, Australia, Japan, and South Africa were also only medical students and physicians. Furthermore, these articles examined the outcome of the educational support programs. A few articles measured the outcomes of the direct-payment programs, for examples, the Ontario Under Serviced Area Program from Canada, the US programs studied by Jackson (2003), other US focused-studies in Pathman (2000 and 2004), and the Friend of Mosvold Scholarship Scheme in South Africa. Pathman et al.(2004) compared the effectiveness and outcomes of financial incentive programs from 40 states in the US. They found that loan repayment and direct payment programs have something in common. For instance, these two programs intensely committed medical students after their graduation and the penalties for incomplete obligatory service was lower than the scholarship program where committed students earlier. The results also showed that the retention rate of participants in loan repayment and direct payment programs were longer compared with the scholarship programs. To conclude, all evaluated articles showed the effectiveness of recruitment at about 33-100% while less than half of evaluated articles showed the effectiveness of retention with a range between 18-90%.

Based on the literature review, there are a few research gaps in the study of the effectiveness of the financial incentive programs:

1. Most studies were from developed countries, and only a few studies were from low-middle income countries (B&B, 2009; Dolea, 2010; Henderson, 2008).
2. Most studies' populations were medical students and physicians (Dolea, 2010). Other healthcare professionals, such as dentists, were rarely examined.

3. The financial incentive programs that were evaluated in the studies mostly were educational support programs, e.g. scholarships, loan forgiveness. A few studies assessed direct payment programs (B&B,2009).
4. There is no study of a high direct payment incentive program (1-3 times of salary).

Thailand as a place of study provides an opportunity to address all these gaps. There is no evidence to show the effectiveness of financial incentive programs for dentists retaining in rural and remote areas in Thailand.

Therefore, in this study, we aim to examine the effectiveness of direct payment financial incentives on decreasing the resignation rate of dentists in rural and remote areas relative to urban areas. We hypothesized that dentists who received higher Hardship Allowance (HA) after 2008 are less likely to resign from **rural** areas. The resignation rates of dentists in rural areas after 2008 decreased compared with those dentists in urban areas.

Background

The Thai Government has implemented financial policies for retaining healthcare providers in rural and remote areas for over two decades. The Hardship Allowance program is a financial incentive that government implemented to reduce the income gap between the private and public sectors. In 2008, the government started a huge revision of Hardship Allowance program. The Hardship Allowance payment in Thailand in 2008 provided extra compensation to new physicians and dentists working in rural and remote areas representing about 100%-300% of their salary. This intervention made the income of new graduated dentists in rural and remote areas higher than new graduated dentists in

urban areas (Pagaiya, 2015). The evaluated study of the Hardship Allowance program is required to provide evidence about the effectiveness of this financial incentive program to the Thai Government and other countries with similar contexts.

Thailand Hardship Allowance Policy Before 2008

Before 2008, the HA policy to attract healthcare professionals to work in community hospitals in rural and remote areas across Thailand had a tiered allowance system as shown in Table 1.1. Since 1989, every new graduated dentist from public school have mandatory service in any community hospitals (urban, rural, remote areas) for three years. After completing three years they can choose to leave or stay in public hospitals. The hardship allowance policy provided direct payment for every public dentist working in hospitals under the MoPH. There is no condition beyond serving in the public hospitals for at least 15 days a month. There is no penalty for leaving the public hospitals in any areas.

At the present, there is no rural and remote definition which every country can applied (Matsumoto, 2008). There is no official definition of rural and remote areas in Thailand as well. The classification of the MoPH for urban, suburban, rural and remote areas are used to determine the areas for the HA payment. The objective of the HA payment policy is to attract, and influence dentists stay longer in the unattractive areas such as rural and remote areas. Before 2008, most areas outside urban city in downtown have been considered rural areas. The remote areas are in some provinces, especially the border provinces. In Thailand has an urban district where city hall and provincial public health office are located. The population density in urban district is approximately more than 500 per square mile. Most district beside urban district are determined rural district

according to MoPH in 2001. The population density in rural district is approximately less than 500 per square mile. The remote districts were mostly the furthest from the urban district, which have difficulty transportation. The population density in remote district is approximately less than 100 per square mile. However, the classification of rural and remotes areas in this study do not comply with this common measure across Thailand. In this study, the rural and remote areas are defined following the MoPH identification (http://bps.moph.go.th/new_bps/node/52).

Table 1.1 shows the Hardship Allowance rate for dentists working in rural and remote areas for 1 year to over than 3 years before 2008. However, the number of dentists who resigned from the hospitals under the MoPH, especially in rural areas, still increased. Therefore, the government decided to increase the Hardship Allowance payment to remain dentists in public hospitals under the MoPH.

Hardship Allowance Policy change in 2008

The number of dentists increased between 2001 and 2008; however, the unequal distribution of dentists persisted. The resignation rate of dentists was also increasing (Dental Department, MoPH, 2008). Financial incentive was the strategy chosen to decrease the resignation rate of dentists. Therefore, in 2008, the government increased the HA significantly, giving the highest direct-payment incentive to dentists working in rural and remote areas as show in Table 1.2. In 2008, the HA rate for dentists depended on years of service and the practice area; for example, dentists who serve in urban and rural areas for 1-3 years would receive $3,750 per year, while their cohorts who serve in remote areas would receive $7,500-$11,250 per year. The HA rate also increased for those who served longer in any community hospitals under MoPH; for example, dentists who served 4-10

years in urban and rural areas would receive $7500 and $11,250 per year, respectively. Compared with the HA rate before 2008, the HA rate for dentists located in rural areas after 2008 increased five times from the previous one.

Table 4.1 The comparison of Thailand's Gross Domestic Product (GDP) per Capita with new graduated dentist's annual salary and annual Hardship Allowance

Year	GDP per Capita	Salary of new graduated dentists	Hardship Allowance	
			Rural	Remote
2007	US$ 3,978	US$ 3,671	US$ 720-938	US$ 3750-7500
2008	US$ 4,380	US$ 3,821	US$ 3,750	US$ 7500-11250
2009	US$ 4,208	US$ 3,821	US$ 3,750	US$ 7500-11250

Before 2008, the hardship allowance in rural areas was about 20-25% of new graduated dentists' salary and 100-200% in remote areas. In 2008, the hardship allowance in rural areas was about 100% of new graduated dentists' salary and 200-300% in remote areas. This table demonstrates the high-powered incentives of the HA policy. New graduated salary was a little bit lower than GDP per capita. But when added with Hardship allowance, dentist work in rural and remote areas would earn higher than GDP.

Theoretical model

In this study we used the utility theory to explain the decision to stay or leave rural and remote areas of dentists. We assumed that dentists have different preference to stay or leave rural and remote areas. They have chosen to locate in the areas that provide them the maximum utilization based on financial and non-financial factors. The simple utility function of dentists' location choice can be denoted as function (1).

$$U(\pi, x; \beta)$$

$$U = f(\pi, x; \beta) \quad (1)$$

Where U is the utility function of dentist choice

π is the financial factors which in this study we estimate the effectiveness of the HA

x is non-financial factors

β is the vector of parameters

We adopted the WHO framework of factors related to the decision to leave or stay in rural areas to account for the non-financial factors. From the WHO 2010 framework, all factors included financial aspect, mandatory service, personal origin and values, family and communities' aspects, working and living conditions, and career related aspect. The 2010 WHO framework is shown in Figure 1.1.

Based on the 2010 WHO framework, besides the financial aspects are non-financial factors. They include personal origin and values, family and community aspects, working and living condition, career related aspect, and mandatory service. The framework of Thai dentist's location choice is established to comply with the 2010 WHO framework, and it is shown in Figure 1.2.

In this study, we aim to measure the choice of dentists to resign from the MoPH in rural areas. We assumed that dentists' preferences, which affect the decision to resign or stay, included both financial and non-financial factors.

Method

Research design and data sources

The study design for Aim1 is a longitudinal retrospective cohort study using an observational database. This study is based on the natural intervention. The Thai government implemented the financial incentive direct payment called "Hardship Allowance" (HA) in Thailand in 2008. The Hardship Allowance is the direct payment

financial incentive for physicians, dentists, pharmacists and other health providers working in primary hospitals under the Ministry of Public Health especially in rural and remote areas. However, in this study we examine the effectiveness of the financial incentive HA on retaining dentists in rural and remote areas. The intervention group in this study is only the dentist group so there is no control group. We used the retrospective observational data of dentists' location from 2003 to 2016 to examine the resignation rate before and after policy implementation. The variation which occurred from the independent or exogenous changes in event across time can identify the effects of Hardship Allowance on the dentists' decision to resign from the MoPH in rural and remote areas.

In this study we measure the resignation rate of dentists by areas and by province. The resignation rates by areas are calculated by the number of dentists who resigned divided by all exist dentists in each area: urban, rural and remote areas. In this study, the area is identified by urban, rural and remote areas as categorized by the Ministry of Public Health Notification Issue 4 (appendix A). The resignation rate of dentists in urban, rural and remote areas before and after the policy implementation are analyzed following the econometric model 1.1.

The number of urban, rural and remote areas in each province is various depending on the size and the urbanization. In this study, the rural and urban provinces are classified by using the percentage of urban hospitals in each province. The urban hospitals are calculated by the number of hospitals in urban areas divided by all hospitals in all areas in the provinces. The percentage of urban hospitals are categorized into 4 quartiles (Q1-4). groups: 1) 7.7-16.7% urban hospitals, 2) 17.6-25% urban hospitals, 3)

26.7-33.3% urban hospitals, and 4) 35.3-100% urban hospitals. The provinces have 7.7-16.7% urban hospitals are indicated the most rural areas and the provinces have 35.3-100% urban hospitals are indicated the most urbanized areas.

The overall resignation rate of dentists is calculated by the number of resignation dentists divided by the number of all public dentists under the MoPH in each province. The number of resignation dentists from 2003 to 2016 are obtained from the Human Resource Management Department, MoPH. However, there is no data of individual dentists from 2003 to 2012. The updated data of individual dentists which obtained from the annual report of Policy and Strategy Bureau MoPH, are available from 2013. Therefore, the number of all dentists in each province each year since 2003 to 2012 must be retrieved from the individual dentist's data in 2013. The number of all dentists in each province from 2003 to 2012 are calculated by using the recruiting year and resigning year from individual dentist's data in 2013. For example, the number of active dentists in 2003 are calculated by counting all dentists who recruited before 2003 and resigned after 2003

Study population

The dentist's population in this study were all the government employees under the Ministry of Public Health (MoPH). Our data contained all public dentist population under the MoPH in Thailand. The resigned dentists' data and the annual report with dentist location data contained information on public dentists who work in community, provincial, and regional hospitals in 76 provinces in Thailand. There was no resigned dentists' data and annual report with dentist location data for public dentists in Bangkok. Dentists who worked in dental colleges (which produce dental nurses), the dental

department in provincial public health office, and the dental department in MoPH were excluded from the study.

The location areas which provided the hardship allowance in 2008 were classified into 5 areas for government documents: urban, suburban, rural, remote1, and remote2 (see Table 1.2). To simplify our model and analyses, we reclassified the areas into 3 areas, including urban, rural and remote. We grouped urban and suburban into urban areas and remote1 and remote2 into remote areas.

The resignation data we obtained, lack of information of active dentists from 2003 to 2012. Therefore, we estimated active dentists during 2003 to 2012 from the annual report dentist location data in 2013. The active dentist is determined to have existed in a given year (2003 to 2012) when their recruitment year is before the given year and their resignation year is after the given year.

Variable used

The dependent variable used in this study is the resignation rate of dentists. We measured the resignation rate of dentists before the policy implementation in 2008 compared with the resignation rate after the policy.

The independent variable is the HA payment policy implementation in 2008 as well as the percent of urban hospitals in each province, each year. The HA payment policy implementation in 2008 is the direct payment financial incentive, which the government provided to the dentists working in hospitals under the MoPH. The urban hospitals were the hospitals under the MoPH which located in urban and suburban areas corresponded with the HA areas in Table 1.2. The urban hospitals were categorized in 4 quartiles (Q1-4). The provinces in Q1, which contained 7.7-16.7% urban hospitals, are

considered the most rural province while the provinces in Q4, which contained 35.3-100% urban hospitals, are considered the most urbanized province. The province in Q2 and Q3 contained urban hospitals between 17.6-25% and 26.7-33.3%, respectively.

Data Analysis

Descriptive statistics were calculated to describe the characteristics of the study population. A bivariate analysis was used to show whether there is any difference between populations, before and after the implementation of financial incentive program. The analysis was conducted at a 95% confidence interval (alpha= .05). A difference in difference regression with fixed effect analysis was then used to estimate the differences in resignation rate in rural areas relative to urban areas before and after the 2008 Hardship Allowance policy implementation.

Econometric Model: Regression model using fixed effect estimation

$$R_{ita} = \alpha_0 + \alpha_1 post_{it} + \mu_i + \gamma_{it} \quad (1)$$

where

R_{ita} is the resignation rate of dentists locate in province 'i' in year 't' in areas 'a' (urban, rural, remote areas)

post is the HA implemented policy, post = 1 if year >= 2008, otherwise post = 0

μ_i is the province i to n.

γ_{it} is the random error term

The first econometric model measured the difference of the resignation rate of dentists in each area: urban, rural, and remote areas. Based on the data set using in this model is the panel data set, therefore xtreg is used to regress this model. The outcomes of the model regression in each area will be compared and discussed. Besides the first

model, we measured the outcome of the overall resignation rate of dentists in different areas before and after the policy implementation by using the econometric model equation #2. In this model the major predictors are the post (HA implementation policy) and the percentage of urban hospitals in each province. The urban hospitals are counted and divided with all hospitals under the MoPH in each province. The percentage of urban hospitals is classified into 4 groups: 0-25%, 26-50%, 51-75%, 76-100%. The provinces which contained 0-25% urban hospitals are considered the most rural province while the provinces which contained 75-100% urban hospitals are considered the urbanized province. The 2nd model can provide the outcome of overall resignation rate in both rural and urban areas after the policy in 2008.

$$\mathbf{Y_{it} = \beta_0 + \beta_1 Rural1_{it} + \beta_2 Rural2_{it} + \beta_3 Urban1_{it} + \beta_4 post_{it} + \beta_5 post.Rural1_{it} + \beta_6 post.Rural2_{it} + \beta_7 post.Urban1_{it} + \beta_m X_{it} + \varepsilon_{it}} \quad \mathbf{(2)}$$

where

- $\mathbf{Y_{it}}$ is the overall resignation rate of dentists in province'i' in year 't'
- **Rural1** is the province in Q1, Rural1= 1 if urban hospital = 7.7-16.7%, otherwise Rural1=0
- **Rural2** is the province in Q2, Rural2= 1 if urban hospital = 17.6-25%, otherwiseRural2=0
- **Urban1** is the province in Q3, Urban1= 1 if urban hospital = 26.7-33.3%, otherwise Urban1=0
- **Urban2** is the province in Q4, Urban2 is a reference among all areas.
- **post** is the HA implemented policy, post = 1 if year >= 2008, otherwise post = 0
- $\mathbf{X_{it}}$ is covariate variables

Results

Dentist Characteristics

Data from Table 4.2 showed that 2,351 dentists resigned from the public health sectors under the MoPH from 2003 to 2016. The resignation dentist is approximately 43.04% of all existed dentists in MoPH. The age groups of dentists in this study were classified into 4 groups: 22-28, 29-35, 36-45, and 46-60 years old. The results in Table 4 clearly show that the 44-60 group has the lower proportion of number of dentists as well as the lower resignation percentage. The 22-28 group has the highest resignation percentage compared with the other age groups. Gender characteristic of Thai dentists showed that most of public Thai dentist are women. The resignation number of female dentists was higher because the overall number was higher, but the percentage of male dentists' resignation was higher than those of female resignation. However, there is no significant different of dentists' resignation rate among gender. Considering resignation by area, it was found that urban and rural dentists resignation percentage was nearly equal at 49.6% and 43.9% respectively, while resignation percentage of remote dentists was the lowest at 6.4%. The resignation percentage by the year of service was consistent with the age. Data showed that dentists who served for 1-3 years was the highest group at 54.7 and the dentists who served more than 21 years was the lowest group at 5.1%. The resignation dentists were much more obvious in the early year of service group. The dentists who served for 1-3 years showed the highest resignation percentage which was at 60.22% followed by the dentists who served for 4-10 years group was at 30.06%, the dentists who served for 11-20 years was at 7.82%, and the dentists who served over than 21 years was at 1.9%.

Table 4.2 Dentist characteristics by resignation status during 2003-2016, n (column%)

characteristics	Resignation 2003-2016		P-value
	Yes (2351)	No (5462)	
Age			
22-28	1,531(66.13)	2,794(51.15)	P < 0.001
29-35	603(26.05)	1,412(25.85)	
36-45	138(5.96)	927(16.97)	
46-60	43(1.86)	329(6.02)	
Gender			
Male	722(31.19)	1,632(29.88)	P=0.251
Female	1,593(68.81)	3,830(70.12)	
Area			
Urban	6,418(49.59)	1,205(52.79)	P < 0.001
Rural	4,666(43.99)	1,029 (38.38)	
Remote	1,029 (6.42)	156(8.46)	
Year of service			
1-3	1,394(60.22)	2,862(52.39)	P < 0.001
4-10	696(30.06)	1,409(25.79)	
11-20	181(7.82)	840(15.38)	
21 up	44(1.90)	352(6.44)	
Region			
North	542(23.41)	1,172(21.45)	P < 0.001
Central	699(30.19)	1,399(25.61)	
Northeast	722(31.19)	1,909(34.94)	
South	352(15.21)	983(17.99)	
Distance			

0-20km	418(18.06)	1,135(20.83)	P < 0.001
21-40km	278(12.01)	278(14.77)	
41-60km	266(11.49)	773(14.15)	
61km ups	1,353(58.44)	2,745(50.25)	

Thailand geography is categorized by 4 regions including North, Central, Northeast, and South regions. The dentists' resignation rate by regions showed that dentists located in the Northeast region had the highest resignation the rate of 31.19%, which is close to the resignation rate 30.19% in central region. Dentists working in the Southern region had the less resignation rate of 15.21%. The distance of hospitals from the urban city or Mueang district, where the downtown of each province is located, is measured. Generally, Provincial Public Health Offices and all government offices are in Mueang(urban) district. The distance between the hospital to Mueang district is classified into 4 groups including 0-20km, 21-40km, 41-60km, and 61km up. It was found that dentist, who located in the hospitals more than 61km away from urban district have the highest resignation rate at 58.44%.

The resignation trend from 2003 to 2016

The line graph in figure 4.3 shows the trend of resignation rate of dentists by areas by years. It is found that the highest resignation rate is in rural areas. The highest rate is 29.6% in 2004. The lowest resignation rate is in remote areas. The resignation trend among urban, rural and remote areas shows that the resignation rate before and after 2008 in urban and remote areas quite not differ. The line graph of resignation rate in urban and remote areas seem straight compared with the line of resignation rate in rural areas. In rural areas the resignation trend is obviously different before and after 2008. The graph

shows that the resignation trend in all areas is decreasing after 2008 especially in rural areas.

The average of dentist resignation rates by urban hospitals within each province

Table 4.3 compared the average of overall resignation by urban hospitals in each province compared before and after the policy implementation in 2008. Data show that the average dentist resignation rate before 2008 higher than the average after 2008. In this

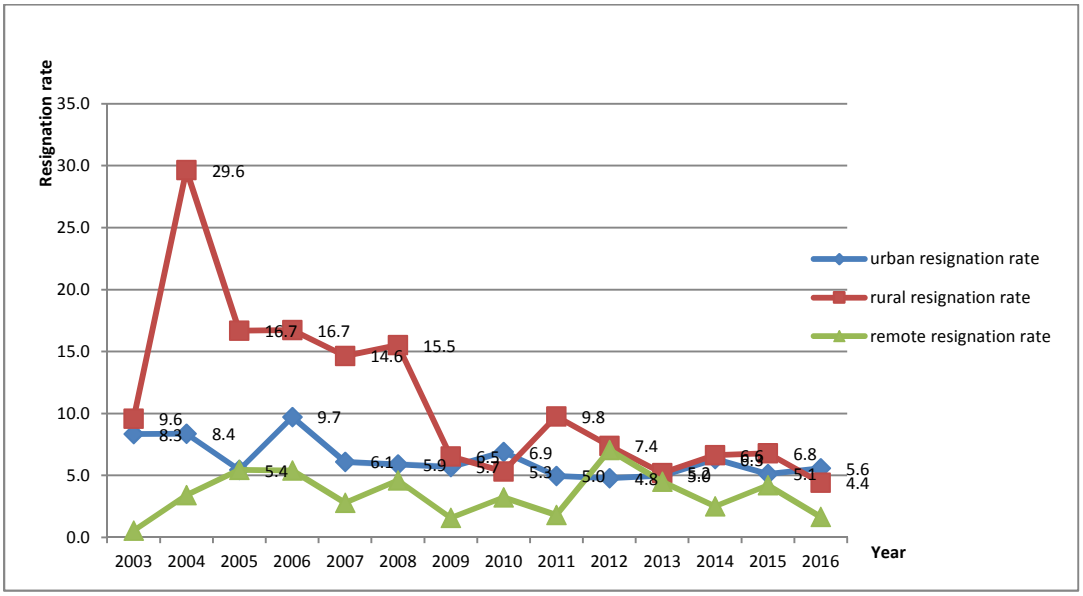

Figure 4.1 Unadjusted trends in resignation rates from 2003 to 2017 by service location (urban, rural, remote)

result table, the urban hospitals are used to represent the rural or urban areas in provincial level. For example, the provinces in Q1 which have the urban hospital 7.7-16.7% represents the rural provinces. The provinces in Q4 which have the urban hospital 33.3-100% represents the urbanized provinces. These rural and urbanized provinces were consistent with the regions shown in Table 4.6. This table showed that most urbanized areas are in province in Central region which is close to Bangkok the capital city. The rural and remote areas are the provinces in Northern, Northeastern and Southern regions

which close to the border of the country. The comparison of the average resignation rate between before and after 2008 showed that in the rural provinces (which urban hospital 7.7-16.7%) has the most difference compared with the average in the urban provinces.

The estimated percentage point changes from fixed effect estimation in resignation rates among rural and remote areas.

Table 4.3 The average of dentist resignation rates by urban hospitals within each province

Areas (%of **urban** hospitals) (N=1063)	Dentist Resignation rate		
	Means Before 2008	Means After 2008	Difference before and after 2008
0-25%	12.98	6.20	-6.78
26%-50%	9.28	5.46	-3.82
51-75%	12.31	6.98	-5.33
76-100%	7.95	4.93	-3.02

Table 4.4 showed the results from the econometric model (1.1) fixed effect estimation analysis by areas. It was found that before 2008, dentists were more likely to resign from the hospital under the MoPH in all areas. The highest resignation rate was shown in rural areas. It was found that the estimate predicted resignation rate of dentist in rural areas before 2008 was at 17.45%. The resignation rate in remote areas is the lowest rate among three areas. After 2008, data showed that the resignation rate in all areas decreased. The highest reduction rate is in rural areas. It was shown that after 2008 the dentist resignation rate reduced by 10.08% per year. The comparison of the resignation rate of dentists in rural and remote areas with urban areas, has shown that the resignation rate in rural areas declined higher rate compared with the resignation rate in urban areas. The reduction of resignation rate in urban and rural areas significantly decreased while in

remote areas the reduction rate insignificantly decreased. Table 4.5 showed the results from the regression analysis from the econometric model (1.2). In this model we also used the percentage of urban hospitals to represent the rural or urban provinces as same as the results shown in Table 4.3. It was found that the overall resignation rate before

Table 4.4 Estimated percentage point by fixed effect estimation in resignation rates among urban rural and remote dentists by province after the 2008 HA policy.

	Urban	**Rural**	**Remote**
After 2008	-2.122** (0.673)	-9.941** (1.421)	-0.071 (1.014)
Intercept	7.510** (0.542)	17.315** (1.130)	3.505** (0.809)
R^2	.009	.047	.000
No of Observation	1,064	1,064	1,064
No of groups	76	76	76
Sigma_u	5.42	10.32	5.66
Sigma_e	10.59	22.25	15.87
rho	.207	.117	.113

Note: standard errors are reported in parenthesis
** indicates significance at 95% level

2008 in all areas increased each year. In this model we used urbanized province as a reference. Before 2008, overall resignation rate was increasing every year in all areas. It was found that after 2008, the overall resignation rate decreased at 3.01%. Our finding shows that the overall resignation rate after 2008, declined in all areas. The resignation rate in rural provinces (7.7-16.7 %urban hospitals) after 2008, significantly decreased at 3.79% compared with the urban provinces.

Table 4.5 Estimated percentage point by difference in difference regression on overall resignation rates among province contained urban hospitals7.7-16.7%,17.6-25%, 26.7-33.3%, and35.3-100%, respectively.

	Overall resignation rate
Intercept	7.95**(1.31)
Post(after2008)	-3.01**(1.09)
Rural1(7.7-16.7%urban hospitals province)	5.09**(1.83)
Rural2(17.6-25%urban hospitals province)	1.27(1.81)
Urban1(26.7-33.3%urban hospitals province)	4.42**(1.91)
Rural1.post	-3.79**(1.52)
Rural2.post	-.76(1.51)
Urban1.post	-2.27(1.58)
R-sq within/R-sq between	.0779/.0005
No. of observation/No. of groups	1,064/76
Sigma_u	5.338
Sigma_e	8.526
rho	.281

Note: standard errors are reported in parenthesis
** indicates significance at 95% level

Discussion

The aim of the study is to examine the effectiveness of the financial incentive program Hardship Allowance program. We used the resignation rate before and after the policy implementation to examine whether the resignation rate has changed. The results in the difference in difference regression analysis, showed that the resignation rate decreased in all areas-urban, rural, and remote-, after the policy implementation. The overall outcomes show that the resignation rate in all three areas decreased

Table 4.6 the group of provinces by region and the percentage of urban hospitals

Region	Provinces in Q1	Provinces in Q2	Provinces in Q3	Provinces in Q4
North	chainat	chiangmai	chiangrai	nakhonsawan
	lampun	kamphaengphet	phichit	phetchabun
	maehongson	lampang		
	nan	payao		
	phitsanulok	prae		
	uthaithani	sukhothai		
	uttaradit	tak		
		uttaradit		
Central	ayutthaya	nakhonnayok	angthong	chacheangsao
	chantaburi	pathumtani	kanchanaburi	chonburi
	trad	phetburi	prachinburi	lopburi
		ranong	singburi	nakhonpathom
				nonthaburi
				prachuapkirikhan
				rayong
				ratchaburi
				samutprakan
				samutsakhon
				samutsongkhram
				suphanburi
Northeast	amnatcharoen	nakhonpanom	burirum	nakonratchasima
	buengkan	roiet	chaiyaphum	sakonnakhon
	loei	ubonratchatani	kalasin	surin
	mukdahan	yasothon	khonkan	
	nongbualamphu		mahasarakam	
	saraburi		nongkhai	

			sakao	
			sisaket	
			udonthani	
South	krabi	chumphon	satun	Nakhonsirtham marat
	narathiwat	pattalung	surattani	phuket
	pattani	songkla		
	phangnga	trang		
		yala		

significantly after the policy implementation although only the resignation rate in remote areas insignificantly decreased. These results clearly show that the direct payment financial incentives have affected the dentists' decision to resign from the rural and remote areas. This outcome is consistent with several studies, which examined the financial incentives strategies (Sempowski, 2004; Barnighausen and Bloom, 2009; Dolea, 2010; Grobler, 2015).

The outcome of the study is consistent with the study's hypothesis. We assumed that the HA direct payment is influential factor for dentist remain in rural and remote areas. The finding shows that after 2008, dentists in rural, urban and remote areas are less likely to resign from their practice location. The study did not have control groups (non-program participants) to compare with the treatment groups (program participants). Nevertheless, we used fixed effect estimation for panel data analyzation to show the causal effect of the policy on the resignation rate of each areas (urban, rural, and remote areas) before and after 2008. The results evidently show that the resignation rate in rural areas significantly decreased after the policy increasing HA in 2008. Moreover, the

resignation rate in urban areas significantly also decreased but the resignation rate reduction in urban areas is lesser than in rural areas.

In urban areas, data showed that the resignation rate from 2003 to 2016 was lower than in rural areas. This result is consistent with many studies (Lexomboon, 2003; Nilnate, 2009). There are several reasons could explain the reason of the results of the resignation rate between before and after. First, most Thai dentists have original background in urban areas (Lexomboon, 2003; Nilnate, 2009; Pagaiya, 2015). Based on the factors related to health workers decision to leave or stay in rural and remote areas, original background is one of the strong influences of health workers decision (Wilson, 2009; Dolea, 2010; WHO, 2010). Most urban dentists who have original background in urban areas are more likely to stay in urban areas. Then some rural dentists who have urban original background are more likely to resign the rural areas and some urban dentists who have urban original background are more likely to stay in the current location. Another reason is the HA payments may affect the urban dentists less than rural dentists because the urban dentists can do dual practice (Wibulpolprasert, 2003; Henderson, 2008). Dentists in urban have more opportunities to earn extra money for working in private clinic in the evening or on weekend. The income from private sectors may be equal or higher than the HA rate. Therefore, in urban areas the HA payments have the less influences for dentists to decide to resign or stay in the practice location compared with rural dentists.

The resignation rate of dentists in remote areas decreased with no significant difference. In the unadjusted trend graph also showed that the resignation rate in remote areas the lowest rate among three areas (urban, rural, and remote areas). The reason may

include the probability that the dentists in remote areas choose to relocate instead resign when they decide to resign their practice location. However, our data is insufficient to justify this assumption. Data set from 2003 to 2016 shows only the resignation rate of dentists. Second reason is the dentists in remote areas required higher incentives to increase the difference between before and after the HA policy implementation. This current HA rate may not be sufficient to motivate remote dentists to remain in their workplace. The last one is the possibility that the financial incentive is not the only factor influence the dentists and other health workers remain in remote areas. Previous studies reported the effectiveness of the integration of financial and non-financial incentives to increase the long retention of health workforce in remote areas (Henderson, 2008; Lehman,2008)

These showed that the HA payment affected the decision of dentists to resign from their practice location especially in rural areas. Although, our data could not provide how long the dentists remain in the rural and remote areas, the data could show that the dentists are less likely to resign from rural areas after the policy implementation. This study is different from other current studies in many ways. For example, most previous studies showed the effectiveness of financial incentive which support education such as scholarship and loan repayment programs (Sempowski, 2004; Baunighausen and Bloom, 2009; Humphrey, 2008; Grobler, 2015). Some studies show the effectiveness of recruiting and retaining at maximum to 100% and 90% respectively (Barnighausen and Bloom, 2009). However, all studies which show high percentage of program's accomplishment used descriptive analysis and there is no control group in the study (Bass & Copeman ,1975) This made several studies were commented the causal effect

explanation of the program and the retention rate of the participants (Barnighausen and Bloom, 2009; Dolea, 2010; Grobler, 2015).

The difference in difference regression with fixed effect estimation is used in this study to minimize the time-invariant variables which the results could show the causal effect of the HA program and the reduction of dentists' resignation rate. The study can show the effectiveness of the HA on retaining dentists in rural areas. Our finding can demonstrate the effectiveness of the direct payment program to stay longer in rural areas. Although, our study has insufficient data to present the period of year that dentists stay longer in rural areas, the finding could show the causal effect of the direct payment program using fixed effect estimation to justify. The study employs pre and post intervention to measure the effectiveness of direct financial payment on resignation of dentists. The method is rigorous evidence to demonstrate the direct payment financial incentive which is the requirement from several current review articles (Humphrey, 2009; Leman, 2007; Barnighausen and Bloom, 2009).

The resignation trend of rural dentist after 2008 was decreasing for a couple of year then it rebound up again. Although the resignation rate did not rise as high as in 2004-2005, the rising of resignation rate after receiving high amount of hardship allowance showed that financial incentives might not be the only factors influencing the decision to resign or stay in practice location of dentists. This outcome is consistent with several studies showed the motivational factors for retaining healthcare provider in rural and remote areas (Henderson, 2008; Lehman, 2008; Humphrey, 2009; Grobler, 2015). Many evidences reported that only financial incentives are not enough to retain health workers in rural and remote areas. The non-financial incentives for example, the good

working and living environment, the provision to school for health worker's children, the opportunity to continuing education all affected the decision of health workers leaving or staying in practice location. These can explain by the utility maximization theory, which dentists decide to resign or stay in rural and remote areas to optimize their utility (Bolduc, 1997).

Evidence support using the financial and non-financial incentives to motivate healthcare workers remain in rural and remote areas (Lexomboon, 2003; Henderson and Tulloch, 2008; Lehman, 2008). Studies show factor related to healthcare workers decision to resign or stay in rural and remote areas include financial factors such as salary supplement, benefit, hardship allowance and non-financial factors such as personal and family factors, working and living conditions, career aspects (WHO, 2010; Dolea, 2010). The results from the study show the variation of the public dentists in MoPH. They are all receive the HA after the policy implementation. Although, most dentists in rural areas who received higher HA rate were less likely to resign compare with the dentists in urban areas who received lower HA rate, there were resigned dentists in rural areas. This various response of dentists demonstrated that higher HA rate is not the only factor for dentists decide to resign or stay in rural and remote areas.

In addition, the mapping graph showed the low resignation rate in rural areas were in the most Northern region and the most Southern regions. Before policy implementation in 2008 the resignation rate of rural dentists was high in Northeastern region and upper part of Central region which far from Bangkok. The resignation rate of rural dentists after 2008 was reducing especially in Northern and Southern region, there were more provinces had resignation rate lower than 5%. However, most provinces in

Northeastern still had resignation rate between over than 5% to 15%. This could be supported the important of non-financial incentives for decision to resign or stay of dentists in Northeastern areas. These variation of the resignation rate among regions showed that dentists have different preference to decide the practice location. However, the constraint of the data set causes our study has not enough evidence to support the influence of non-financial incentives. We expected to have future study contain complete data and can explain comprehensively the relationship between financial and non-financial factors on health providers decision to resign or stay in rural areas.

Conclusion

The study showed that after the policy implementation in 2008 the overall resignation rate of dentists decreased especially in rural areas. These showed that the Hardship Allowance payments affected the decision to resign rural areas of dentists. Although, there is insufficient data to explain how long the direct payment HA could decrease the resignation rate of the dentists, we can conclude that the Hardship Allowance programs could retain dentists in rural and remote areas.

Limitation

The resignation data set was incomplete. There is no active dentists contained in the resignation data set. To show the resignation rate, which we choose to be an outcome for answer our research questions, we must estimate active dentists from the annual report data set in 2013-2016. Although this method provides number of active dentists, it is the underestimated number of dentists, which is lessen the reliability of the study outcome.

The most important limitation in this study is lack of the true rural-urban measurement. The unit of analysis of the study is the province-year. However, we could not comprehensively define the rural-urban provinces. In the study, we measured the rural-urban provinces by estimating from the number of the urban hospitals in each province. Consequently, the results show some rural provinces, which estimated from the urban hospitals, are the attractive province and have low resignation rate. This indicate the inconsistent areas using the urban hospitals estimation.

Furthermore, the data source of this study is obtained from the annual report of Human resource management which contained a few variables. There are some variables unavailable from the data set. For examples, variables which related with the non-financial incentives is not included in the annual report. Based on the conceptual framework showed the factor related to the decision of dentists to leave or stay in rural and remote areas involved with financial and non-financial factors. However, the observational data is contained mostly the financial factor variables and some personal characteristics of dentists. Therefore, the outcome shows the restricted evidence to analyses and discuss to complete to theoretical concept.

This study we used the resignation rate to measure the effectiveness of the hardship allowance. We assumed that the resignation rate decreased mean the dentist retained in rural areas however in our study did not show whether they are still in the rural areas. They may be move from rural to urban areas which our data are restricted to answer whether they move from rural to urban or stay in rural.

Another limitation is this study we used the resignation rate to measure the effectiveness of the HA programs. Even though the outcome showed that the resignation

rate reduced after the HA program implementation, we do not know the long-term effect of the program. Our data we obtained have no retention rate to show the true retention before and after the program.

CHAPTER 5

MANUSCRIPT 2

THE EFFECTS OF FINANCIAL INCENTIVE REDUCTION ON LOCATION CHOICE OF RURAL AND REMOTE DENTISTS: EVIDENCE IN THAILAND[2]

[2] Noochpoung R., Hair N., Hung P., Puttrasri W., Chen B., to be submitted to BMD Health Service Research

Abstract

Both developed and developing countries generally use financial incentives to tackle the disparity distribution of healthcare workers. Previous studies showed the effectiveness of financial incentives on recruitment and retention of healthcare workers. However, most studies were conducted in developed countries and assessed positive incentives programs. Few studies evaluated the effect of financial incentive reduction on the health workers' decision to stay or leave their practice location in low-middle income countries. This study aims to examine the impact of financial incentive reduction, due to the changed HA areas categorization, on rural and remote healthcare workers. A retrospective observational study was conducted. Data on the rural and remote dentist's location annual report, including the relocation and resignation from 2013 to 2018, were obtained from the Human Resource Management Department and the Policy and Strategy Bureau at the Ministry of Public Health (MoPH) in Thailand. Segmented regression was used to analyze the effect of Hardship Allowance reduction on dentists' decision to stay or leave their location. Data of 2,384 rural and remote dentists is examined to determine the location choice between the changed and unchanged areas categorization after the policy implementation in December 2016. The outcome shows that the resignation of dentists in unchanged and changed areas is not significantly different. However, the relocation of dentists from rural to urban in changed areas after the policy implementation is more likely to increase significantly.

In conclusion, the direct payment reduction does not affect the number of resignations, but the relocation of dentists. The dentists decide to leave their location after the direct payment HA reduction policy was implemented. Therefore, the reduction of

financial incentives could deteriorate the retention of health workers in rural and remote areas.

Introduction

The disparities distribution of the healthcare workforce between urban and rural areas is a global issue (WHO, 2010). WHO (2010) showed that the proportion of healthcare providers per population was higher in urban areas compared to rural areas. Many studies showed that healthcare workers prefer to work in urban areas (Dussault, 2005; Henderson, 2008;). Statistics showed that about 50% of world population live in rural areas while approximately 38% of nurse and 25% of physicians provided health care in rural areas. Both developed and developing countries have experienced this uneven distribution of healthcare workers (Dolea, 2010; WHO, 2010).

The consequence of this uneven health workers is the restricted access to healthcare of people in areas that have a low density of health workers. The disparity of health service in rural and remote areas is related to the lack of healthcare providers in these areas (Dussault, 2005; Henderson, 2008; WHO, 2010). Evidence shows that the shortage of a healthcare workforce is associated with the population's health outcome (Chen, 2004; Henderson, 2008). For instance, data from WHO reported that the five-year children mortality rate is high in countries that have a low density of healthcare workers (Henderson, 2008).

The lack of oral healthcare professionals in rural and remote areas is also part of the same global health issues (Kruger 2005). For example, Kruger showed that in some parts of Western Australia the dentists per 100,000-population ratio was 5.9, while it was 43 in the capital cities. This same disparity of dental health providers happened in

Thailand, too. For example, in 2013, dentist per 100,000-population ratios was 96 in Bangkok, while it was 7 in the Northeastern region (Lapying & Puttasri, 2013). As a result, the areas with the higher dental supply showed the higher dental care services. For example, the dental care utilization of Bangkok citizens in 2011 was 0.27 visit/person/year, but the dental care utilization of Northeastern region people was 0.12 visit/person/year.

To improve health outcomes and increase equitable access to healthcare for the rural population, WHO recommended strategies to recruit and retain qualified healthcare providers in rural and remote areas. These strategies include educational, mandatory services, professional and personal support, and financial incentives interventions (WHO, 2010; Dolea, 2010). Among those recommended strategies, financial incentives are the strategy which is selected the most to address the healthcare worker issues, both in developed and developing countries where confront with the shortage of healthcare workers especially in rural and remote areas (Humphrey, 2009; Dolea, 2009; Grobler, 2015).

Evidences show the effectiveness of financial incentives for recruiting and retaining healthcare workers in rural and underserved areas (Dolea, 2010; Sempowski,2004; Barnighausen and Bloom, 2009; Grobler, 2015). Most studies evaluated and reporting the effectiveness of financial incentives program were from developed countries, for examples the USA, Japan, Australia, Canada, etc. The financial incentives program from these countries was mostly the scholarship and loan repayment programs. Moreover, the study population mostly were medical students and physicians.

There are few studies that include study population in dentists and other health professionals (Barnighausen and Bloom, 2009).

Background

Thailand is also one developing country using financial incentives strategies to address the inequitably distributed healthcare providers in urban and rural areas. The Thai government implemented direct payment financial incentives called Hardship Allowance (HA) to motivate health profession stay in primary hospitals under the Ministry of Public Health (MoPH). Since 2001, the HA are provided to healthcare providers including physicians, dentists, pharmacists, nurses, etc., to retain them in rural and remote areas.

The highest rate HA policy was launched in 2008. The government implemented the Hardship Allowance policy, which provides 100% of salary to rural dentists and 200% to 300% of salary to remote dentists. The evaluated study showed that the HA policy could reduce the resignation rate of dentists in rural areas significantly.

However, in 2013, the government adjusted the rate and criteria of payment which reduced the HA rate of Dentists who located near the city and Dentists who served over 4 years. This significant change happened again in December 2016 when the government adjusted the HA areas. Some rural areas became urban areas which reduced the HA rate. Table 1 shows the criteria and rate of HA payment in 2008 and 2016, and the reduction of HA payment when rural areas became urban areas.

Many studies examined the effectiveness of the financial incentive on recruitment and the retention of healthcare workers. However, few studies evaluate the impact of financial strategy when the government has to change the policy to match the status of

Table 5.1 Hardship Allowance annual payment in 2008, 2016 and the reduction after the policy changed the areas categorization

In 2008					
Year of services	Urban	Suburban	Rural	Remote 1	Remote 2
1-3 years	$3,750	$3,750	$3,750	$7,500	$11,250
4-10 years	$7,500	$9,375	$11,250	$15,000	$18,750
11-20 years	$9,375	$11,250	$15,000	$18,750	$22,500
21 years up	$11,250	$15,000	$18,750	$22,500	$26,250
In 2016 until the present					
1-3 years	$3750	$3750	$3750	$3750	$7500
4-10 years	$4500	$5625	$7500	$11250	$15000
11 years up	$5625	$7500	$9375	$15000	$18750
The difference if rural areas become urban areas					
1-3 years		$3750 -$3750 =$0			
4-10 years	$4500 -$7500 =-3000(40%)	$5625-$7500 = -875(25%)			
11 years up	$5625-$7500 = -3750(50%)	$7500 -$9375 =-1875(20%)			

resources and economics in the country. This study aims to examine the effect of financial incentive reduction on rural and remote healthcare workers. In this study, we used rural and remote dentist data in Thailand to represent the healthcare workers in rural and remote areas from low-middle income countries.

Theoretical model

In this study, we used the utility theory to explain the decision to stay or leave rural and remote areas of dentists. We assumed that dentists have different preference to stay or leave rural and remote areas. They have chosen to locate in the areas that provide them the maximum utilization based on financial and non-financial factors. The simple utility function of dentists' location choice can be denoted as function (1).

$$U(\pi, x; \beta)$$

$$U = f(\pi, x; \beta) \quad (1)$$

Where

U is the utility function of dentist choice

π is the financial factors which in this study we estimate the effectiveness of the HA

x is non-financial factors

β is the vector of parameters

We adopted the WHO framework of factors related to the decision to leave or stay in rural areas to account for the non-financial factors. From the WHO 2010 framework, all factors included financial aspect, mandatory service, personal origin and values, family and communities' aspects, working and living conditions, and career related aspect.

Based on the 2010 WHO framework, besides the financial aspects are non-financial factors. They include personal origin and values, family and community aspects, working and living condition, career related aspect, and mandatory service. The framework of Thai dentist's location choice is established to comply with the 2010 WHO framework, and it is shown in Figure 1.2.

In this study, we aim to measure the effect of the HA reduction, due to recategorization in HA areas from rural to urban in December 2016, on rural and remote dentists' resignation and relocation. We assumed that Rural and remote dentists who located in the changed areas which HA was reduced in December 2016 are more likely to leave (resign and relocate) from their areas. Therefore, after 2016, the resignation and relocation of dentists in changed areas increase.

Method

This is a longitudinal retrospective cohort study using an observational data. The study is based on the natural intervention of the policy implementation of reducing the Hardship Allowance rate by reclassifying the rural and urban areas for allocating HA in Thailand in December 2016. The Hardship Allowance is the direct payment financial incentive for physicians, dentists, pharmacists and other health providers working in primary hospitals under the Ministry of Public Health especially in rural and remote areas. In 2008, the Thai government launched a policy for attracting healthcare providers to stay longer in rural and remote areas by providing a direct payment financial incentive called “Hardship Allowance”.

In 2008, the HA in rural areas was about 100% of new graduated dentists’ salary and 200-300% in remote areas. After the economic growth and urbanized expansion, in December 2016 the government adjusted the HA area categorization. Some rural areas became urban areas causing the reduction of the HA rate in those areas. The adjusting HA area categorization criteria followed the Notification of MoPH on December 2012. It was identified that all areas in each province were reclassified to urban, rural or remote areas based on several criteria. First, it is the difficulty of transportation from the working

location to the urban city within the province, and to another big province nearby. Second, it is the urbanization within the working area's district, such as the number of commercial banks, the number of medical and dental private clinic, the number of convenient stores, the annual revenue of local government in district level, etc. Third, it is the dentist shortage situation in that area. The last criteria, it is whether or not the areas are in the risk zone, which are the three provinces on the southern border of Thailand.

After the announcement of new criteria for the reclassification of the HA areas, each provincial public health office has to collect and analyze data and send the list of new area categorizations to the MoPH. Then the Policy and Strategy Bureau, in the MoPH collected all the reports from every provincial public health office and distributed them throughout the MoPH Notification Issue#11. The list of new areas reclassified and distributed in December 2016 has shown in Appendix B.

In this study, we examine the effect on dentists' decision to leave or stay in rural and remote areas, from the financial incentive HA reduction, due to the adjusting HA area categorization in some rural areas. The policy affects all the dentist populations in the study. The intervention group in this study is only the dentist group so there is no control group. Therefore, we used the retrospective observational data of dentists' location from 2013 to 2018 to examine the dentists' resignation and relocation before and after policy implementation in 2017. The observational data of dentists' location before and after policy implementation in 2017 contains variation due to HA reduction program. This variation, which occurred from the independent or exogenous changes in events across time, can identify the effects of the Hardship Allowance reduction on the dentists' decision to stay or leave rural and remote areas.

The effect of dentists' resignation and relocation after policy implementation in the areas that changed from rural areas to urban areas was measured. We compared the resignation and relocation of dentists between the changed areas and unchanged areas to show the characteristics of dentists in these two areas. Because the data set, we obtained is the longitudinal data of individual dentists from 2013 to 2018, we can do the panel data analysis. We estimated the resignation and relocation of rural and remote dentists in the changed areas and unchanged areas after the policy implementation in December 2016 by using interrupted time series regression for panel data analyzation.

Sources of data

Data sources used for addressing this study's aim included the dentists' data from 2013 to 2018, and the rural and remote areas data adjusted in December 2016. The dentist data was obtained from the Policy and Strategy Bureau, which is revised from the annual reported data of Human Resource Management Division, Permanent Secretary Bureau, MoPH from 2013 to 2018. The data contained individual dentist's data in each year from 2013 to 2018. The individual dentist data includes dentists' characteristics, for example, gender, age, year of service, and geographic location of each dentist by year. The changed status of rural to urban is obtained from the notification of the MoPH issue # 11,12 by the Policy and Strategy Bureau, MoPH in December 2016.

Study population

The study population in this study is rural and remote dentists who work in primary hospital under MoPH across the country during 2013 to 2018. We excluded data of rural and remote dentist who died, retired, or fired for any reason.

Unit of analysis

The unit of analysis in this study is the individual dentist-year working in rural and remote primary hospitals under MoPH from 2013 to 2018.

Dependent variable

To achieve the study's aim, the dependent variable is whether an individual dentist who was working in rural and remote primary hospitals under the Ministry of Public Health **resigned** or relocated (to urban areas) from their location from 2013 to 2018.

Key explanatory variable

The key explanatory variables are the time during the implementation policy in December 2016 and the changed areas. The recategorized HA areas policy in December 2016 is implemented in some rural areas which become urbanized areas. Some rural areas became urban areas in December 2016, and as a result the HA payment rate reduced. The objective of the recategorized HA areas' implementation in December 2016 is to adjust the areas to comply with the economics and urban expansion. The HA payment criteria in December 2016 is the same as the payment criteria in 2013 as shown in Table 1.

The major variables in the Econometric model for the study are composed of:

RuraltoUrban is the changed areas, ruraltourban =1 if the rural areas became in urban areas in December 2016, otherwise ruraltourban=0

Post in the econometric model identified when is the time that policy implementation, after December 2016 post = 1, otherwise = 0.

Post * RuraltoUrban is the interaction of the time of the policy implementation and

the changed area status from rural to urban areas, if after December 2016 and in the changed areas, post*ruraltourban is = 1, otherwise = 0

Covariate variables

The covariate variables use to accomplish the study are following these variables:

Age is recorded in number in data set. Age of dentists in resignation and relocation data is the current age at the time they leave from the MoPH. Age will be categorized in 4 groups: 1 = age 23-28 years, 2 = age 29-35 years, 3 = age 36-45 years, 4 = 46-60 years

Gender of rural and remote dentists is record in text in data set. Two value of dentists' gender is recorded for male and female.

Year of service is recorded in number in data set. Year of services is the duration that dentists working in any rural and remote primary hospitals under the MoPH. It is calculated from the different of recruitment date which is a date when dentist start working in MoPH and resignation date which is a date when dentist quit working in MoPH.

Region is the geographic area. In Thailand is divided into 4 regions: 1=Northern region, 2=Central region, 3=Northeastern region, and 4=Southern region.

Distance is the distance from the dentist's practice location (primary hospital) to the urban city in each province. The distance in this study is measured in kilometer (1 kilometer = 0.62 mile). In the econometric model for Aim 2 the distance is categorized in 4 groups: 1=0-20km., 2=21-40km.,3=41-60km., and 4=61km.ups

Data analysis

Descriptive statistics are calculated to describe the characteristics of the study population. A bivariate analysis is used to demonstrate whether there is any difference

between before and after December 2016. Mantel-Haenszel chi square test is conducted to measure if there are any differences in these characteristics between, before, and after December 2016. The analysis is conducted at a 95% confidence interval (alpha =.05). A segmented regression analysis for panel data is then used to estimate the differences in rural and remote dentist's resignation and relocation where the area is changed after the 2017 implemented policy.

Econometric Model

Difference in difference regression with fixed effect estimation:

$Y_{it} = \beta_0 + \beta_1 ruraltourban_{it} + \beta_2 post_{it} + \beta_3 post_{it}.ruraltourban_{it} + \varepsilon_{it}$

From this model we applied into 3 models, **where** Y_{it} are the resigned dentists, the relocated to urban dentists, and the resign and the relocated to urban dentists following these:

1) Y_{it} is whether rural and remote dentist 'i' resigned in year 't' , $Y_{it} = 1$ if dentist 'i' resigned in 't', otherwise $Y_{it} = 0$;

2) Y_{it} is whether rural and remote dentist 'i' relocate to urban in year 't' , $Y_{it} = 1$ if dentist 'i' relocate to urban in 't', otherwise $Y_{it} = 0$;

3) Y_{it} is whether rural and remote dentist 'i' resigned in year 't' , $Y_{it} = 1$ if dentist 'i' resigned in 't', otherwise $Y_{it} = 0$ $_t$

$Ruraltourban_{it}$ is the changed areas, ruraltourban =1 if the rural areas became in urban areas in December 2016, otherwise ruraltourban=0

$Post_t$ is the policy implementation, post = 1 if year >= 2017, otherwise post = 0

$Post.ruraltourban_{it}$ is the time after policy implementation interaction with the changed area in year 't'

X_{it} is covariate variables

Results

Dentist Characteristics

The characteristics of rural and remote dentists locating in unchanged areas and changed areas from 2013 to 2016 show in Table 5.2. The unit of the dentists' number in this table is dentist-year. Unchanged area is the location, which is identified rural area before and after December 2016. On the other hand, changed area is the location which is identified rural area before December 2016 but after that it became urban area. The age of dentists is categorized into 4 groups. There are 22-28-year-old, 29-35-year-old, 36-45-year-old, and 46-60-year-old. Data shows that rural and remote dentists in this study mostly are age between 29-35 years both in unchanged and changed areas. The number of the youngest group age 22-28-year-old are the second and mostly located in unchanged areas. About 30% of rural dentists are in middle age group 36-45-year-old and most of them locating in changed areas. The oldest group which age 46-60-year-old are less than 10% of all rural dentists. Most of the oldest group are in the changed areas as same as the middle age group.

Data show the majority of dentists in Ministry of Public Health in Thailand are female. In this study, about 70% are female dentists. Even though, the number of female dentists showed that they are in unchanged areas. The proportion of male in unchanged and changed areas is 1.6 while the proportion of female in unchanged and changed areas is 1.1.

According to the HA rate and criteria in 2013 and 2016 by MoPH, the year of service are categorized into three groups: 1-3-year, 4-10-year, and 11-year ups.

Table 5.2 Dentist characteristics by rural to urban policy status during 2013-2018, n (person-year) (column %)

characteristics	Rural to urban policy		P-value
	Unchanged areas N= 6,242	Changed areas N= 4,971	
Age			
22-28	2, 276 (36.46)	908 (18.27)	P < 0.001
29-35	2,566 (41.11)	2,194 (44.14)	
36-45	1,174 (18.81)	1,491 (29.99)	
46-60	226 (3.62)	378 (7.60)	
Gender			
Male	2,247(36.00)	1,359(27.34)	P < 0.001
Female	3,995(64.00)	3,612(72.66)	
Year of service			
1-3	2,259(36.19)	877(17.64)	P < 0.001
4-10	2,760(44.22)	2,372(47.72)	
11 ups	1,223(19.59)	1,722(34.64)	
Region			
North	1,526(24.45)	1,402(28.20)	P < 0.001
Central	723(11.58)	2,136(42.97)	
Northeast	2,345(37.57)	925(18.61)	
South	1,648(26.40)	508(10.22)	
Distance from hospital to the urban city in each province.			
0-20km	400(6.41)	937(18.85)	P < 0.001

21-40km	946(15.16)	2,488(50.05)	
41-60km	1,896(30.37)	1,009(20.30)	
61km ups	3,000(48.06)	537(10.80)	

Nearly half of them have been working under the MoPH for 4-10 years. Among these 3 groups, the proportion of the smallest experience group (1-3 years) are the highest group which locating in the unchanged areas. Thailand geography have been classified in 4 regions: North, Central, Northeast, South regions. The unchanged areas mostly are in Northeastern region. About 40% of changed areas are in Central regions. This is consistent with the distance from the practice location areas to the urban city in each province. Due to unchanged areas mostly are further the urban city in each province than changed areas, and most of unchanged areas are in the Northeastern region. In this study, the distance to the city are categorized in 4 groups: 0-20km.,21-40km., 41-60km., and 60km ups. Data shows that nearly 50% of the furthest locations (60km ups) are the unchanged areas. Another 30% of the further location which has a distance about 41-60 km. from the city also are the unchanged areas. Contrarily, about 50% of location which has a distance 21-40 km. from the city are in the changed areas. In addition, the nearly 20% of location which less than 20 km from the city are in the changed areas.

The results in Table 5.3 shows the number of rural and remote dentists who stay or leave from the rural areas between the dentists in unchanged and changed areas from 2013 to 2018. However, the unit of dentists' number is a dentist because we count the resignation, relocation of dentists each year. In 2013 to 2014, dentists in unchanged areas resigned more than dentists in changed areas about 0.4%, while all dentists who relocated to urbans areas are from the unchanged areas. As well as, the number of resigned dentists

Table 5.3 Dentist location status by rural to urban policy during 2013-2018, n (column %)

Year	Location status	Rural to urban policy		P-value
		Unchanged areas (rural_rual)	Changed areas (rural_urban)	
2013-2014	Resign	84(7.4)	63(7.0)	P=0.016
	Relocated to urban	17(1.5)	0(0)	
	Relocated to rural areas	6(0.5)	5(0.6)	
	Stay	1,032(90.6)	836(92.5)	
		1,139(100)	**904(100)**	
2014-2015	Resign	115(10.5)	71(8.2)	P < 0.001
	Relocated to urban	73(6.7)	2(0.2)	
	Relocated to rural areas	34(3.1)	42(4.9)	
	Stay	872(79.7)	747(86.7)	
		1,094(100)	**862(100)**	
2015-2016	Resign	84(8.1)	42(5.2)	P=0.001
	Relocated to urban	29(2.8)	1(0.1)	
	Relocated to rural areas	6(0.6)	11(1.4)	
	Stay	912(88.5)	753(93.3)	
		1,031(100)	**807(100)**	
2016-2017	Resign	124(11.8)	59(7.5)	P=0.002
	Relocated to urban	21(2.0)	12(1.5)	
	Relocated to rural areas	8(0.8)	0(0)	
	Stay	902(85.5)	714(91.0)	
		1,055(100)	**785(100)**	

2017-2018	Resign	64(6.8)	34(4.7)	P < 0.001
	Relocated to urban	47(5.0)	16(2.2)	
	Relocated to rural areas	21(2.2)	18(2.5)	
	Stay	812(86.0)	658(90.6)	
		944(100)	**726(100)**	

from the unchanged areas are higher than the resigned dentists from the changed areas during 2015 to 2018. In addition, the number of dentists in the unchanged areas who relocated to urban areas are also higher than the number of dentists in the changed areas significantly during 2015 to 2018.

Mapping of the percentage of changed areas by province

The map graph in Figure 5.1 and 5.2 shows the mapping of percentage of urban areas before and after the policy implemented in December 2016 by province on Thai maps. This showed how the areas changed from rural areas to urban areas. The dark blue is stand for the highest rate and the light blue is stand for the lowest rate of changed areas. The map demonstrates that most of the changed areas located in the province in central region. Most provinces in northeastern region and provinces near the border of the country contain the lower percentage of changed areas. In this study, the changed areas are the areas which were identified rural after the policy implemented in December 2016, these areas became urban areas. This map can be explained that most rural areas in the central regions became urban areas which is understandable. Because most provinces in central regions are close to Bangkok the capital city which easy to urbanization. Figure 5.3 (green) shows the average of resignation dentists by province. Comparing mapping

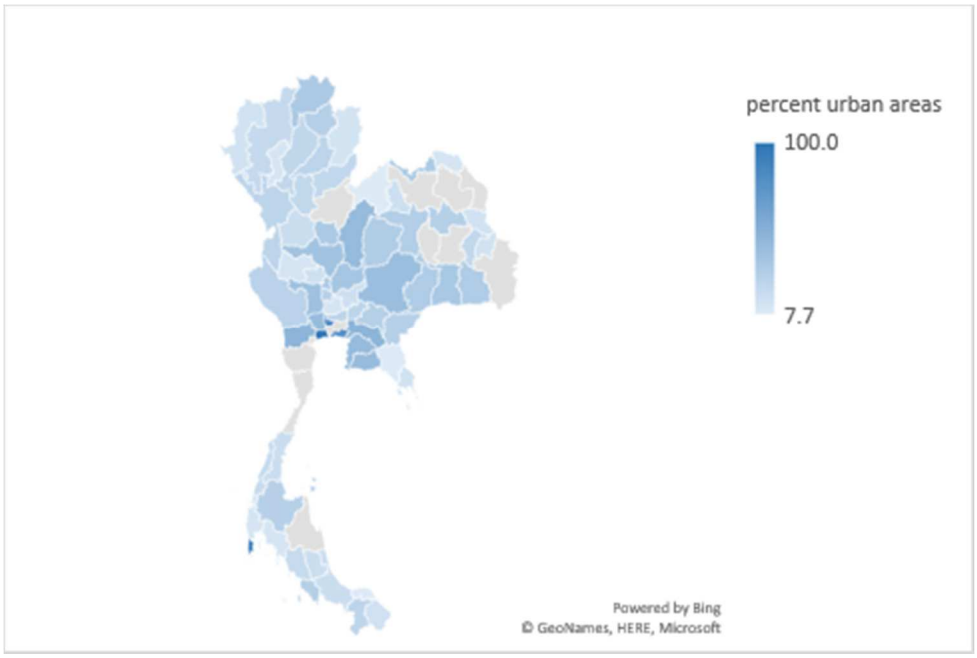

Figure 5.1 Mapping graph of percent of urban areas by province in 2013

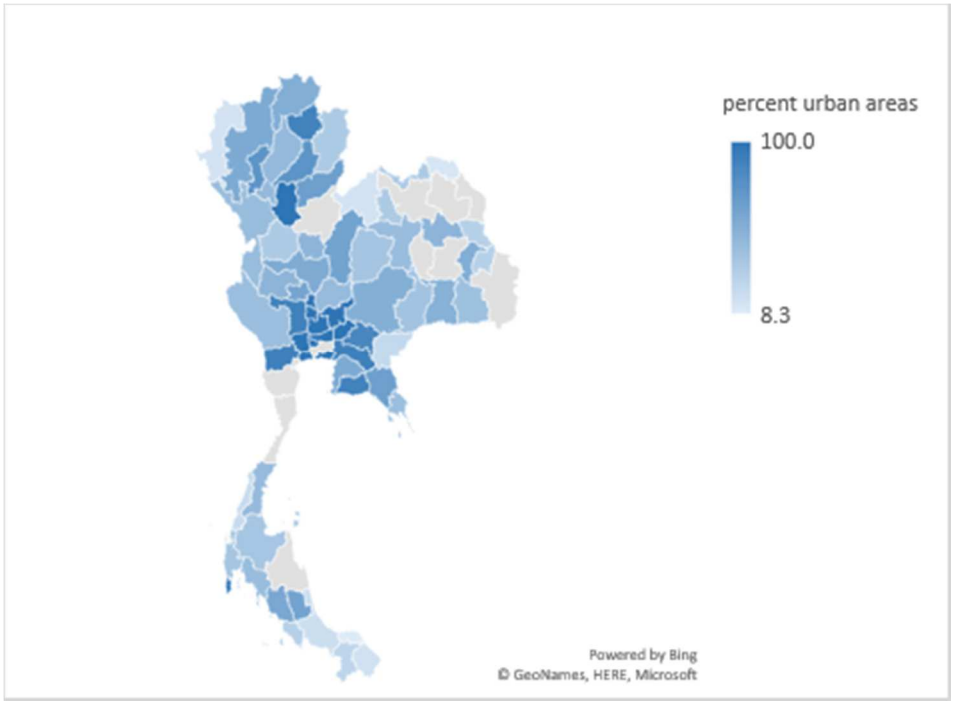

Figure 5.2 Mapping graph of percent of urban areas by province after December 2016

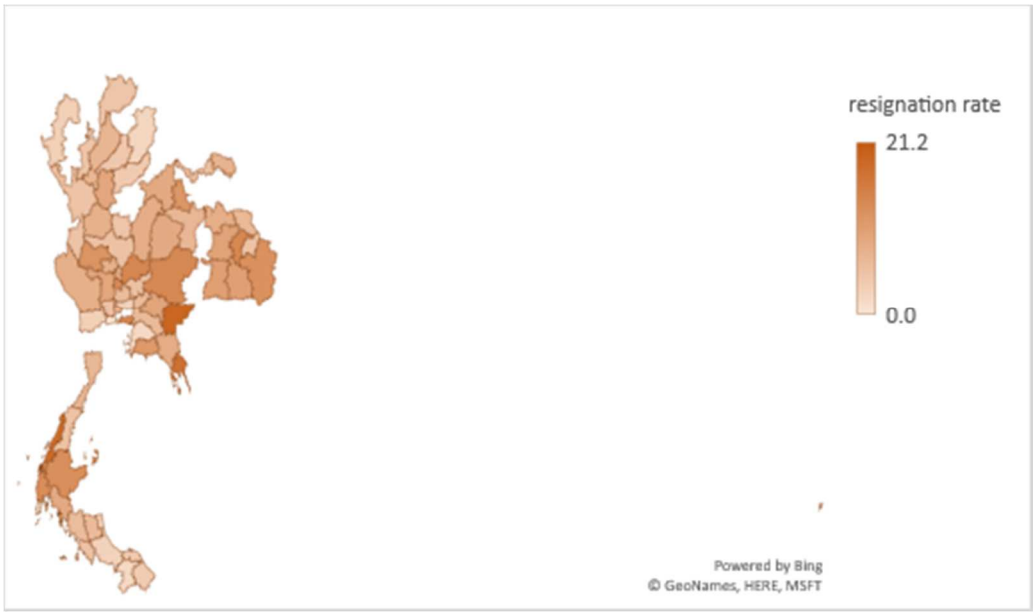

Figure 5.3 Mapping graph of resigned dentists by province

Figure 5.4 Mapping graph of relocated dentists by province

graph in Figure 5.2 and 5.3, it is found that the high average resignation is not in the central region where located most changed areas but the border in northeastern region where located most unchanged areas. Figure 5.4 shows the percentage of relocation to urban of dentists. The map graph showed that provinces which contain high percentage of changed areas have more relocation percentage.

The resignation trend by area changed from 2013 to 2018

The trend graph (Figure 5.5) shows the resignation rate of dentists from 2013 to 2018 in unchanged and changed areas. The graph shows that both resignation trend between unchanged and changed areas are similar pattern. However, the resignation rate in unchanged areas is higher than in changed areas. After policy implementation in 2017 and 2018 the unchanged areas still rural areas, but the changed areas became urban areas. This shows that dentists in unchanged areas (close to rural areas) are more likely to resign from their location, while dentists in changed areas (close to urban areas) are less likely to resign from their location. Figure 5.6 shows the pattern of relocation rate of rural dentists in unchanged and changed areas from 2013 to 2018. The trend shows that the relocation rate of dentists in unchanged areas increased since 2013 continuously until dropping in 2017. After 2017, the relocation trend in unchanged areas is more likely to grow up. The relocation trend of changed areas quite stable since 2013 but after the policy implementation in December 2016, the trend is rising persistently.

The estimated percentage point from difference in difference regression on resignation and relocation rates among rural and remote areas.

We applied the regression analysis for panel data to analyze the effect of the HA rate reduction, due to the recategorized HA areas policy in December 2016, on

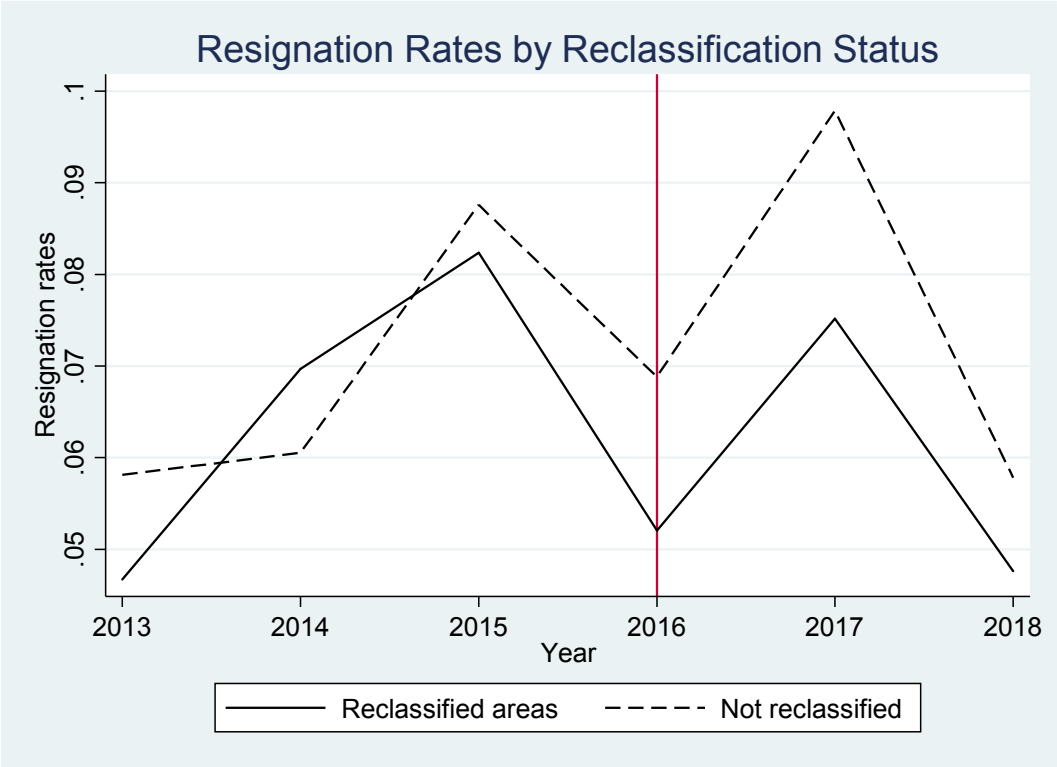

Figure 5.5 unadjusted trend graph of dentists resignation rate by years from 2013 to 2018

resignation and relocation rate of dentists in rural and remote areas. The results table shows that the resignation dentist in changed area increase insignificantly compared with unchanged areas. However, comparing the resignation rate before and after policy implementation in December 2016, the resignation of dentists increases significantly. Nevertheless, the regression results show that the resignation of dentists in changed areas after the policy implementation is no difference from the resignation in changed area before 2017.

Table 5.4 show the results of the regression analysis for panel data to analyze the effect of recategorized HA area policy in December 2016, which reduced the HA rate, on

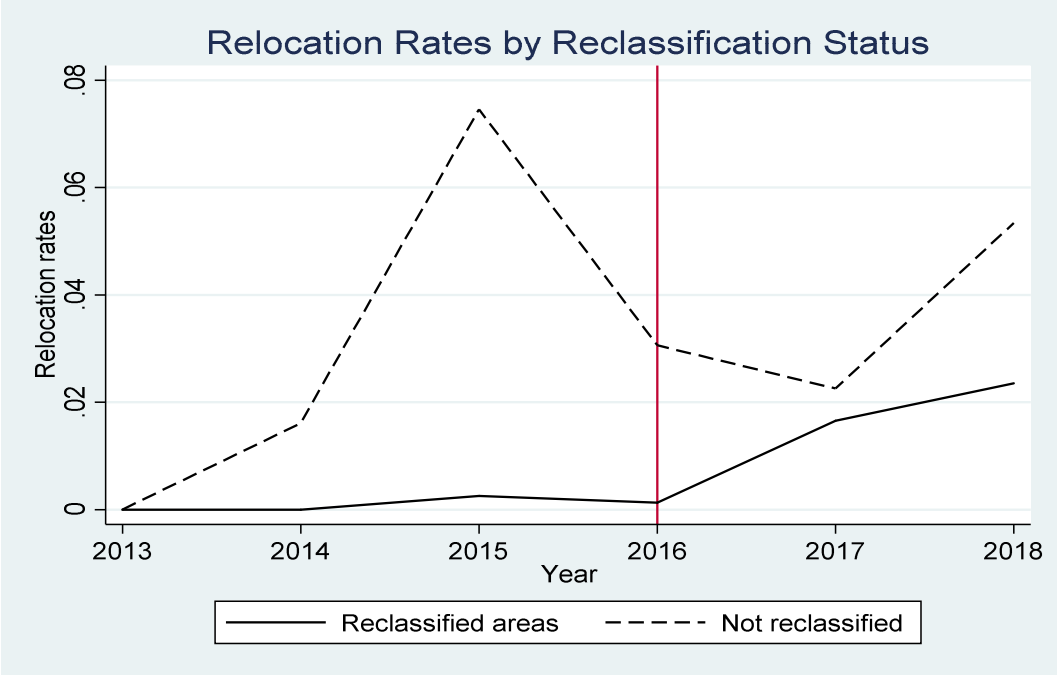

Figure 5.6 unadjusted trend graph of dentists' relocation rate by years from 2013 to 2018

relocation of dentists. The results table shows that the relocation of dentist in changed area decreases significantly, while from 2017 which is the year after the policy implementation the relocation of dentists insignificantly decreases. Nonetheless, it is found that the relocation of dentists in changed areas after the policy implementation, increases significantly.

Table 5.5 show the results of the regression analysis for panel data to analyze the effect of recategorized HA area policy in December 2016, on resignation and relocation of dentists in rural and remote areas. The results table shows that the resignation and relocation of dentist in changed area decreases significantly. On the other hand, after the policy implementation the resignation and relocation of dentist significantly increases. In addition, the regression table shows that the resignation and relocation of dentist in

changed areas after policy implementation increases significantly (at significant level 0.1).

Discussion

This study aims to assess the effect of HA payment reduction, due to the changed HA areas from rural to urban, on the decision to leave or stay in rural areas. The finding shows that dentist resignation was not significantly different between the changed and unchanged areas after the policy implementation in December 2016. However, the rural and remote dentists who relocated to urban areas were more likely to increase in changed areas after the policy implementation. This finding demonstrates that HA reduction influences dentists to leave rural areas although they do not resign. Based on the payment rate in Table 1, the HA payment reduced from 20 to 50%. Therefore, we could imply that the HA reduction could minimize the retention of dentists in rural areas. This finding corresponds to the results of the study of job motivation in North Viet Nam, which showed that the low salary and allowances discouraged rural health care workers (Dieleman, 2003).

The study of evaluating the effect of financial incentive reduction, as well as our study, is rarely found. Most of the evaluated program financial incentives studies show the results after implementing financial incentives. For example, the scholarship and loan repayment program in many developed countries (Sempowski, 2004; Barnighausen and Bloom, 2009) examined the retention of health workers after providing financial support. However, there are some studies that showed the effect of reducing financial support for retaining health providers in underserved or rural areas. For example, in 1990 and 1991,

Table 5.4 Regression analysis on resignation of dentists between changed and unchanged areas after the policy implementation

	Resignation	**Relocation**	**Resignation&relocation**
Intercept	.54**(.003)	.077**(.013)	.128**(.013)
Post(after2016)	.054**(.005)	-.001(.005)	.052**(.007)
Ruraltourban	.008(.006)	-.132**(.029)	-.120**(.028)
Post.ruraltourban	-.006(.008)	.025**(.006)	.018(.010)
R-sq within	.020	.017	.022
R-sq between	.031	.021	.003
No. of observation	11,213	10,381	11,213
No. of groups	2,384	1,975	2,384
Sigma_u	.374	.076	.368
Sigma_e	.181	.144	.228
rho	.810	.220	.722

the study of the National Health Service Corps program, and the relation with the access and service of people in underserved areas in the US, showed that reduced support from the NHSC affected the reduction of physicians in underserved areas (Stone et al. 1991; Brown et al. 1990). In 1994, Pathman et al. findings also revealed that poor financial incentives programs caused the retention in underserved areas of NHSC physicians less than non-NHSC physicians did. These studies are indirect evidence to support our

finding. The outcomes of our study, which show the effect of the reduction of direct payment financial incentives, will be further evidence to benefit the policy makers.

Our finding that the resignation of dentists in changed areas is insignificantly different with the unchanged areas after the policy implementation, but the relocation of dentists in changed areas is significantly higher than in the unchanged areas after the policy implementation, which could be explained by several reasons. First, the increasing of the number of dentists across countries due to the government policy in 2005 affected the decision to resign as government employees under the MoPH. The increasing dentists make the highly competitive in dental service market especially in urban city. Some public dentists may be reluctant to resign to compete with other private dentists, which increase every year. Second, the social norm of most Thai people provides a high value and respect for the government employee. Many dentists accepted the low income by working with the MoPH because they can be the government employee. Therefore, the reduction of HA payment may reduce their income, but it cannot influence them resign from the MoPH. This reason can explain by utility theory when dentists preferred non-financial incentives. Third, the increasing of HA payments in 2008 combined with other financial supplements (non-private fee (1995); professional fee (2005)) secure the financial status of these government employee's dentists. Generally, if we do not compare the income of MoPH's dentists with the income of private dentists, the average income of MoPH's dentists is higher than Thailand's GDP per capita.

In addition, the increasing of the relocation of dentists in changed areas after the policy implementation in December 2016 could be clarified by these reasons. First, the number of recruited dentists increase from the educational strategy and mandatory

service strategy affect the decision to resign or relocate of dentists in rural and remote areas. In Thailand, the public dentists who have at least 2 years of services can get permission to relocate. Dentists in changed areas mostly have more experience than most dentists in unchanged areas which make changed areas dentist are more likely to be eligible to relocate. These dentists choose to move before the favorable positions are occupied. Second, relocation to urban areas for most dentists means relocating near their home. Many dentists have original backgrounds in urban areas (Lexomboon, 2003). Therefore, relocating near hometowns reduces the cost and time of commuting. This commuting reduction may compensate with the HA reduction. Third, relocating near the urban city increases more opportunity to get extra income from working extra hours in either public sectors or private sectors (Wibulpolprasert, 2003; 2008). The suburban or urban areas mostly have higher density populations, which mean these areas require more oral health service than in the rural areas. Besides, the suburban or urban population mostly have more potential to afford the cost of dental care treatment compared with rural people. Fourth, relocating to urban areas in many places provides more opportunity to continue education. For example, the big city such as Chiang Mai, Khon Kan, Song Kla, there are the universities in the urban city. Relocating near the urban city makes it easy to attend the conference or use the library of the university or contact the professor, etc. Fifth, the urban cities have many amenities that can make life more convenient and comfortable. These can attract some dentists who prefer lifestyles in a big city to relocate to near an urban city because of this reason (Henderson, 2008).

The resignation trend graph of dentists in unchanged and changed areas showed similar trends; however, the resignation of dentists in unchanged areas is higher than in

changed areas due to the characteristic of the unchanged areas. Because unchanged areas are rural areas before and after the policy implementation, and most of them are further from the urban city. This characteristic make unchanged areas are unattractive compared with changed areas. This finding demonstrates that the resignation of dentists in rural areas which is unattractive areas is higher than in urban or suburban areas. Even though there is HA payment in changed areas decreased, the resignation of dentists in changed areas did not increase significantly. This finding shows that we have not enough evidence to prove our hypothesis that financial incentive reduction increase resignation rate of dentists. This outcome shows that the financial incentive is not the only factor that motivates health workers' decision to leave or stay in their practice location, but non-financial factors are also influential (Dieleman, 2003; Henderson, 2008).

Based on the study's conceptual frameworks, it shows that the decision of dentists to stay or leave rural areas depends on financial and non-financial incentives. In this study, the financial incentive that we focus on is the HA. The outcomes of the study show that the financial incentive in our model cannot comprehensively explain the resignation of dentists in changed and unchanged areas. There are non-financial incentive variables missing from our model. To make accurate clarification on all factors that influence dentists' decisions, more study is required. The finding that only financial incentives are insufficient to motivate dentists working in rural and remote areas corresponds with the review article by Henderson. He found that the significance of financial incentive in terms of salaries, benefits and allowances affect the healthcare workers in most developing countries (Henderson, 2008). In countries with low salaries, mostly in developing countries, the additional monetary incentives could attract healthcare workers

to relocate to rural and remote areas. Only financial incentives are not enough for motivating health workers to remain in rural and remote areas, but non-financial incentives, such as good working and living conditions, the opportunity for continuing education, the professional and personal support programs, are also significant motivation (WHO, 2004; Stilwell B, 2004; Vujici, 2004; Humphreys,2009).

Conclusion

The results of the study show that the reduction of HA payment affect the decision of dentists to stay or leave their location practice. As a result, the disparity distribution of dentists still exists. Besides, a new problem may take place as new dentists recruit to replace the rural and remote areas for 1 or 2 years, and then they relocate to urban or suburban areas.

Consequently, the rural and remote areas must recruit new dentists every year or every two years. It will establish a cycle of recruit and relocate in the rural and remote areas. Moreover, these can create another issue. For example, the increasing dentist's policy combined with the reduction of HA might cause the congestion of dentists in urban areas, and rural areas would still have a dental supply shortage.

Limitation

Data source of the study is obtained from the annual report of Human resource management which contained a few variables. There are some variables unavailable from the data set. For examples, variables which related with the non-financial incentives is not included in the annual report. Based on the conceptual framework showed the factor related to the decision of dentists to leave or stay in rural and remote areas involved with financial and non-financial factors. However, the observational data is contained mostly

the financial factor variables and some personal characteristics of dentists. Therefore, the outcome shows the restricted evidence to analyses and discuss to complete to theoretical concept.

CHAPTER 6

MANUSCRIPT 3

THE RELATIONSHIP OF DENTISTS' AGE AND DENTISTS' LOCATION CHOICE WHEN THE FINANCIAL INCENTIVE DECREASING: EVIDENCE FROM THAILAND[3]

[3] Noochpoung R., Hair N., Hung P., Puttrasri W., Chen B., to be submitted to BMD Health Service Research

Abstract

Financial strategy extensively used to address the inequitable distribution of health workers worldwide either in high-income or low-income countries. Several studies showed the effectiveness of financial incentive in recruiting and retaining health providers in rural and remote areas. However, few studies have investigated the relationship between the health providers' age and their location choice when the financial incentive is reduced. This study aims to examine the relationship between dentists' age and dentists' location choice on financial incentive reduction, due to the recategorization of Hardship Allowance (HA) areas in Thailand. A retrospective observational study was conducted. Data on the rural and remote dentists' location annual report, including the relocation and resignation of dentists from 2013 to 2018, were obtained from the Human Resource Management Department and the Policy and Strategy Bureau at the Ministry of Public Health (MoPH) in Thailand. Triple differences regression with random effect estimation was used to analyze the panel data of dentists' resignation and relocation by age groups, in changed areas after the policy implementation. Data of 2,384 rural and remote dentists from 2013 to 2018 were used. The percentage of dentists by age groups 22-28, 29-35, 36-45, and 46-60-year-old is 28%, 42%, 23%, and 5.4%, respectively. About 70% of 22-28-year-olds, and 29-35-year-olds are in rural areas, while approximately 60% of the other two groups are in urban areas. The regression analysis of dentists' resignation and relocation on dentists' age in changed areas after the policy implementation shows that the oldest group in changed areas is the less likely to resign significantly from their location after the policy implementation compared with the youngest group.

In conclusion, dentists' age is related with the dentists' decision to leave or stay in rural and remote areas when the HA was reduced. Although, the policy implementation caused the reduction of financial incentives, most of the oldest group decided to stay in their practice location. Besides financial incentive, age is another factor that influences that the dentists' decision to leave or stay in rural and remote areas.

Introduction

The shortage of health professional especially in rural and remote areas is a global issue (WHO, 2010). Statistics show that health workers worldwide are mostly located in urban areas while most of the population are in rural areas (WHO, 2010). Most healthcare providers prefer living in urban cities than in rural and remote communities (Dussault, 2005; Henderson, 2008). For example, in the US, about 20% of people are in rural areas, while there is only 9% of physician service there (Hancock et al., 2009). In Australia approximately 2.6 physicians per 1000 population are in urban cities, while there is only 0.9 physician per 1000 people in rural communities (Viscomi, 2013). Many countries in Southeast Asian, including Thailand, also are challenged with the same problem. For example, in Vietnam, 70% of the population live in rural areas, but about 1/3 of rural health centers have no physician (Vujicic, 2011). In Cambodia, physician density in urban city is 0.41 per 1000 population, while in some remote areas the physician density is 0.06 per population (Chhea, 2010).

In addition, statistics shows the shortage of dental supply in rural and remote areas affected the utilization of oral healthcare service (Lapying & Puttasri, 2013; 2014). Although, a few studies report the shortage of oral health care workers, there is a study in California that shows that approximately 70% of communities with dental supply

shortages are rural. Areas with a lower supply of dentists have higher percentages of minorities, children, and low-income populations (Mertz, 2001). A study found that dentists in a major city in Australia were 0.59 per 1,000 population, but in rural and remote areas there were 0.28 and 0.16 per 1,000 population (Teusner, 2005). In Thailand in 2013, the statistics from the Thai dental council shows that in Bangkok dentists were 0.96 per 1,000 population, while in Northeastern region dentists were 0.07 per 1,000 population.

The disparity distribution of health workers is related with health outcomes (Chen, 2004; Henderson, 2008). The insufficiency of qualified health providers in rural and remote areas minimizes the access to health care service for the population in those areas (Dussault, 2005; Henderson, 2008). Data shows the association of the child mortality rate and low density of healthcare workers (Henderson, 2008). In other words, with lower health worker density comes higher child mortality rates. Oral health service also has a similar problem. For example, in 2011, the dental care service of people in Bangkok was 0.27 visit/person/year, while it was 0.12 visit/person/year in the Northeastern region.

The current evidence shows that financial incentives are significant factors in motivating health workers to locate in rural and remote areas (Sempowski, 2004; Barnighausen and Bloom, 2009; Dolea, 2010). Several studies conducting surveys on the significant factors motivating health workers who serve rural and remote people showed that the financial incentives or monetary factors are the most important for healthcare providers to decide whether to leave or stay their location (Adzei, 2012; Awofeso, 2010). However, many studies report that only financial incentives

are insufficient to attract health workforce in the rural communities especially in the low-middle income countries (Lehman, 2008; Henderson, 2008; Humphrey, 2009).

Several studies suggest that financial incentive is not the only significant factor motivating health providers to locate in rural and remote areas. Non-financial factors are also important in attracting health workforce. Studies show the achievement of integrating financial and non-financial strategies to address the shortage of health workforce in unfavorable areas (Henderson, 2008; Humphrey, 2009). Based on the WHO (2010) framework showing the factors related to health workers' decision to leave or stay in rural and remote areas, besides financial incentives, non-financial factors included: personal and family factors, working and living conditions, career aspects, and professional and personal support.

This study examines the relationship of personal factors (age) and health worker's choice of location when the financial incentive is reduced. Based on the Hardship Allowance (the direct payment financial incentive from the Thai government) criteria, the payment rate depends on the area and the year of service. This relationship implies that the dentists' age is associated with the HA rate payment. The evidence of the relationship between health worker's age and their location choice is required, because at the present, this relationship is still inconclusive.

A different connection between age and practicing location decisions was found (Lexomboon, 2003). Generally, relationships between the decision for leaving a practice location and demographic characteristics, such as age, gender, education level are indecisive (Lehman, 2008). In 1990, Easterbrook explored how factors influenced family medicine location decisions and found that age

was no significant factor on physician decisions. However, the study of the impact of job satisfaction on worker turnover found that the higher the age of the workers, the more likely they are to leave their present work (Lamber, 2001).

In 2005, Richards showed there was a high percentage of older health workers (>50 years) practicing in rural areas, while another study reported the average ages of health workers in urban and rural areas were 36.1 and 36.8, respectively (Richards, 2005; Ebuehi, 2011). In 2013, Antwi identified the impact of wages on the retention of health workers. The author stated that age was important and focused on young adults aged 20-35-years old (Antwi, 2013). These studies showed the various results regarding the relationship between age and health worker's decision. Evidence is still required to show the actual association of age on practice location decisions of the healthcare workforce.

Background

Thailand is a low-middle income country using financial incentive strategies to address the inequitably distributed healthcare providers in urban and rural areas. The Thai government implemented direct payment financial incentives, called Hardship Allowance (HA), to motivate health professionals to stay in primary hospitals under the Ministry of Public Health (MoPH), especially in rural and remote communities. Since 2001, the HA are provided to healthcare providers, including physicians, dentists, pharmacists, nurses, etc., to retain them in primary hospitals principally in rural and remote areas.

The highest rate HA policy was launched in 2008. The Hardship Allowance policy was implemented by the government provides 100% of new graduated dentists' salary to rural dentists and 200% to 300% of new graduated dentists' salary to remote and

very remote dentists. The evaluated study showed that the HA policy could reduce the resignation rate of dentists in rural areas significantly.

However, in 2013, the government adjusted the rate and criteria of payment which reduced the HA rate of dentists who were located near the city and dentists who served over 4 years. This significant change happened again in December 2016 when the government adjusted the HA areas categorization. Some rural areas became urban areas, which reduced the HA payment rate. Table 5.1 shows the criteria and rate of HA payment in 2008 and 2016, and the reduction percentage of HA payment when rural areas became urban areas.

From Table 5.1, the HA payment rate reduction from the changed policy implementation shows that there is different of reduction rate among the dentists' year of service and dentists' location practice. For dentists who serve 1 to 3 years, the changed areas did not affect their HA payment. For either rural or urban locations, there is no HA payment rate different for the dentists with 1-3 year of experience. For dentists who serve 4 to 10 years, the difference of rural and suburban areas and the difference of rural and urban areas are 25% and 40%, respectively. In addition, for dentists who serve over 11 years, the difference of rural and suburban areas and the difference of rural and urban areas are 20% and 50%, respectively.

Based on the literature review, there are a few research gaps in the study of the relationship of health providers' age and health providers' location choice on the financial incentive for the retainment of health providers in rural areas, especially in low-middle income countries. This research uses Thailand as a place of study and provides an opportunity to address all these gaps. Moreover, at the present there is no evidence to

show the effect of financial incentive reduction on rural and remote dentists' choice to leave or stay their practice location and how this decision relates with dentists' age in Thailand.

This study we aim to determine the relationship between dentists' resignation and dentists' age after the decrease in HA due to the 2016 policy change of practice location area categorization. We hypothesized that rural and remote dentists who affect the most from the HA reduction are more likely to leave their practice location compared with the group that has little or no effect from the decreased payment. Based on our hypothesis, the older group who affected more from the reduction of HA are more likely to resign and relocate from the rural areas compared with the younger dentists.

Theoretical model

In this study, we used the utility theory to explain the decision to stay or leave rural and remote areas of dentists. We assumed that dentists have different preference to stay or leave rural and remote areas. They have chosen to locate in the areas that provide them the maximum utilization based on financial and non-financial factors. The simple utility function of dentists' location choice can be denoted as function (1).

$$U(\pi, x; \beta)$$

$$U = f(\pi, x; \beta) \qquad (1)$$

Where

U is the utility function of dentist choice

π is the financial factors which in this study we estimate the effectiveness of the HA

x is non-financial factors

β is the vector of parameters

We adopted the WHO framework of factors related to the decision to leave or stay in rural areas to account for the non-financial factors. From the WHO 2010 framework, all factors included financial aspect, mandatory service, personal origin and values, family and communities' aspects, working and living conditions, and career related aspect.

Based on the 2010 WHO framework, besides the financial aspects are non-financial factors. They include personal origin and values, family and community aspects, working and living condition, career related aspect, and mandatory service. The conceptual framework of Thai dentist's location choice is established to comply with the 2010 WHO framework, and it is shown in Figure 1.3.

Method

Research design

Our study design is a longitudinal retrospective cohort study using an observational data. The study is based on natural intervention of the policy change. The Thai government implemented the policy reducing the Hardship Allowance rate by changing the categorization of dentist's working location used for allocating HA in Thailand in December 2016. Since 2000, the Thai government has launched a policy for attracting healthcare providers to stay longer in rural and remote areas by providing a direct payment financial incentive called "Hardship Allowance". The Hardship Allowance is the direct payment incentive for physicians, dentists, pharmacists and other health providers working in primary hospitals under the Ministry of Public Health, especially in rural and remote areas.

In 2008, the HA in rural areas was about 100% of newly graduated dentists' salary and it was 200-300% in remote areas. After the economic growth and urbanized expansion, the government adjusted the HA area categorization in December 2016. Some rural areas became urban areas causing the reduction of the HA payment rate. The adjustment of the HA area categorization criteria plans has been issued since December 2012 through the Notification of MoPH. It was identified that all areas in each province had to reclassification for the urban, rural or remote areas based on several criteria following these criteria. The first criteria is the difficulty of transportation from the working location to the urban city within the province and to another big province nearby. Second is the urbanization within the working area's district, such as number of commercial banks, number of medical and dental private clinic, number of convenient stores, annual revenue of local government in district level, etc. Third is the dentist shortage situation in that area. And the last one is the areas that are in the risk zone, which are the three provinces at the southern border of Thailand. After that, the MoPH mailed the criteria to recategorize the rural and remote areas to every provincial public health office to consider and adjust the area in their province. Subsequently, the provincial public health office reported the new categorization to the MoPH to reconsider before launching the policy in December 2016.

The adjusted working areas are collected and distributed through the Ministry of Public Health Notification Issue #11 and the list of new areas after the change in December 2016 are shown in Appendix B. In this study, we investigate the relationship between dentists' retention and dentists' age after influence by the financial incentive HA reduction due to the adjusted HA area categorization in some rural areas. The policy

affects all dentist populations in the study. The intervention group in this study is only the dentist group, so there is no control group. Therefore, we used the retrospective observational data of dentists' location from 2013 to 2018 to examine the change of location choice before and after policy implementation. The observational data of dentists' location before and after the policy implementation in December 2016 contains variation in the Hardship Allowance reduction program. This variation, which occurred from the independent or exogenous changes in events across time, can identify the effects of Hardship Allowance reduction on the dentists' resignation in relation to the dentists' age.

In this study, we measure the relationship of the age with the resignation and relocation rate of rural and remote dentists after the adjusted areas policy in December 2016. We compared the resignation and relocation of dentists in each age group (22-28, 29-35, 36-45, 46-60) between the changed areas and unchanged areas to show the characteristics of dentists in these areas. Due to data set that we obtained is longitudinal data of individual dentists from 2013 to 2018, we can conduct the panel data analysis. We estimate the resignation and relocation of dentists in each age group in the changed areas after the policy implementation by using segmented regression for panel data analyzation.

Sources of data

The data sources used for addressing the research question in this study is the data of dentists from 2013 to 2018, and the rural and remote areas data adjusted report in December 2016. The data of dentists obtained from the Policy and Strategy Bureau, which is revised from annual reported data from the Human Resource Management

Division under the Permanent Secretary Bureau in the MoPH from 2013 to 2018. The set is contained data of individual dentists in each year from 2013 to 2018. The individual dentist data include their characteristics for example gender, age, year of service, and geographic location of each dentist by year. The changed areas data that some rural areas became urban areas is obtained from the notification of the MoPH issue # 11,12 by the Policy and Strategy Bureau, MoPH in December 2016 (Appendix B).

Study population

The study population is all dentists who worked as a government employee in rural and remote primary hospitals under MoPH across the country during 2013 to 2018. In this study we excluded data of rural and remote dentists who is identified the resignation reason as death or retirement or termination from the job for any reason.

Unit of analysis

The unit of analysis in this study is the individual dentist-year working in healthcare facilities in rural and remote areas under MoPH from 2013 to 2018.

Dependent variable

To achieve the aim of the study, the dependent variable is whether an individual dentist working in rural and remote primary hospitals under the Ministry of Public Health **resigns** or relocates to urban areas from 2013 to 2018.

Key explanatory variables

The key explanatory variables for this study are the time of the policy implementation in December 2016, the changed or unchanged areas, and the dentists' age. In this study, we aim to measure the relationship of dentists' leaving from rural and remote areas and dentists' age in changed areas after the policy implementation. The HA

areas changed policy in December 2016 is implemented in some rural areas which became urbanized. Some rural areas became urban areas in December 2016, causing the HA payment rate to be reduced. The objective of the recategorized HA areas implementation in December 2016 is to adjust the areas to comply with the economics and urban expansion. The HA payment criteria in December 2016 is the same as the payment criteria in 2013, as shown in Table 1.2. The major variables in the Econometric model for this study are composed of:

RuraltoUrban is the changed areas, ruraltourban =1 if the rural areas became in urban areas in December 2016, otherwise ruraltourban=0

Post in the econometric model identified when the time implementation of the changed area status in December 2016, after December 2016 post = 1, otherwise = 0.

Age is recorded in number in data set. Age of dentists in the data set is the current age at the time they quit from the MoPH or relocate to urban areas. Age will be categorized in 4 groups: 1 = age 23-28 years, 2 = age 29-35 years, 3 = age 36-45 years, 4 = 46-60 years.

Post * RuraltoUrban is the interaction of the time of the policy implementation in December 2016 and the changed area status from rural to urban areas, if after December 2016 and in the changed area, post*ruraltourban is = 1, otherwise = 0

RuraltoUrban*Age is the interaction of the changed area status from rural to urban areas and the dentists' age

Post *RuraltoUrban*Age is the interaction term of the time of the policy implementation in December 2016, the changed area status and the dentists' age,

we can see how age affect the dentist's resignation and relocation to urban areas when practice location status changed after the policy implementation in December 2016 .

Covariate variables

The covariate variables use to accomplish the aim of the study are following these variables:

Gender of rural and remote dentists is record in text in data set. Two value of dentists' gender is recorded for male and female.

Year of service is recorded in number in data set. Year of services is the duration that dentists working in any rural and remote primary hospitals under the MoPH. It is calculated from the different of recruitment date which is a date when dentist start working in MoPH and resignation date which is a date when dentist quit working in MoPH.

Region is the geographic area. In Thailand is divided into 4 regions: 1=Northern region, 2=Central region, 3=Northeastern region, and 4=Southern region.

Distance is the distance from the dentist's practice location (primary hospital) to the urban city in each province. The distance in this study is measured in kilometer (1 kilometer = 0.62 mile). In the econometric model for this study the distance is categorized in 4 groups: 1=0-20km., 2=21-40km.,3=41-60km., and 4=61km.ups

Data analysis

Descriptive statistics are calculated to describe the characteristics of the study population. A bivariate analysis is used to demonstrate whether there is any difference between before and after December 2016. Mantel-Haenszel chi square test is conducted to measure if there are any differences in these characteristics between, before, and after

December 2016. The analysis is conducted at a 95% confidence interval (alpha =.05). A triple difference regression with random effect estimation for panel data is then used to estimate the differences in rural and remote dentist's resignation and relocation where the area is changed after December 2016 implemented policy.

Econometric Model: triple differences regression with random effect estimation:

$Y_{it} = \beta_0+\beta_1 ruraltourban_{it} + \beta_2 age_{it}+ \beta_3 post_{it}+ \beta_4 post.ruraltourban_{it} + \beta_5\, post.age_{it}+ \beta_6 ruraltourban_{it}.\, age_{it} + \beta_7\, post.ruraltourban_{it}.age_{it} +\beta_m X_{it} + \varepsilon_{it}$

where :

Y_{it} are the outcome variables including the resigned dentists, the relocated to urban dentists, and the resign and the relocated to urban dentists following these:

1) Y_{it} is whether rural and remote dentist 'i' resigned in year 't' , $Y_{it} = 1$ if dentist 'i' resigned in 't', otherwise $Y_{it} = 0$;

2) Y_{it} is whether rural and remote dentist 'i' relocate to urban in year 't' , $Y_{it} = 1$ if dentist 'i' relocate to urban in 't', otherwise $Y_{it} = 0$;

3) Y_{it} is whether rural and remote dentist 'i' resigned in year 't' , $Y_{it} = 1$ if dentist 'i' resigned in 't', otherwise $Y_{it} = 0_t$

$Ruraltourban_{it}$ is the changed areas, ruraltourban =1 if the rural areas became in urban areas in December 2016, otherwise ruraltourban=0

Age_{it} is the dentist 'i' age in year't', age is categorized in 4 groups: 1 = age 23-28 years, 2 = age 29-35 years, 3 = age 36-45 years, 4 = 46-60 years

Post is the time of policy implementation, post = 1 if year >= 2017, otherwise post = 0

$Post.ruraltourban_{it}$ is the time after policy implementation interaction with the changed areas in year 't'

$Post.age_{it}$ is the time after policy implementation interaction with the age of dentist 'i' in year 't'

$ruraltourban_{it}.age$ is the changing status areas in year 't' interaction with the age of dentist 'i' in year 't'

$Post.ruraltourban_{it}.age_{it}$ is the time after policy implementation interaction with the changing status areas in year 't' interact with the age of dentis 'i' in year 't'

X_{it} is covariate variables

Results

Dentist Characteristics

Data of dentists' characteristic of rural and remote areas by age groups from 2013 to 2018 are shown in Table 6.1. The unit of the dentists' number in this table is dentist-year. In this study, the age groups of rural and remote dentists are categorized into 4 groups: 22-28, 29-35, 36-45, and 46-60-year-old. The oldest age of dentists is 60 years old because they are the government employees. In Thailand, all government employees retire at age 60 years old. Most rural and remote dentists from 2013 to 2018 are age between 29-35-year-old (42%). About 28% of them age between 22-28-year-old, follow by the group of age 36-45-year-old is 23%. The oldest group (46-60-year-old) are the smallest groups at about 5.4%. It is found that there are more female than male dentists in all age groups except in the oldest group where there are more male dentists. The year of service is consistent with the dentists' age. Most of the youngest dentist have served 1-3 years and most of the oldest dentist group have more than 11 years of service.

In 2013, that we initially only recruited rural and remote dentists' data. These rural and remote dentists started to relocate to urban and other rural and remote areas in

2014. In 2017 and 2018, all location in changed areas became urban areas. Data shows that approximately 70% of rural dentists are the younger and youngest age groups. The middle age and the oldest age groups are in urban areas at 60% of all age groups.

Data of dentists by region shows that most of the youngest groups are in the Northeast region while most of the oldest groups are in the North and Central regions, respectively. The dentists age 22-28 years most located in the Northeast region follow by the South, Central and North regions, respectively. The younger age groups and the middle aged group are distributed in any region proportionately. In contrast, the dentist age 46-60-year-old are mostly located in the North region, followed by the Central, Northeast, and South regions, respectively.

The distance from hospital to the urban city in each province are categorized into 4 groups: 0-20 km., 21-40km., 41-60km., and over than 61km. Most urban hospitals are in the urban city or distance less than 20km from the city. The rural hospitals are further from the urban city than the urban hospitals and the remote hospitals are the furthest among three areas. Data shows that the youngest age dentists group mostly located in the furthest areas (over than 61 km. from the urban city). It is found that the older age the dentist is the closer the dentist locates to the urban city.

The results in Table 6.2 show the dentists' location status in unchanged areas and changed areas by age groups. It is found that most of resigned dentists are the youngest group both in unchanged and changed areas. Although the number of dentists' resignation is higher in the unchanged areas than in the changed areas, the proportion is equal at 14.6% and 14.0%, respectively. If consider only the number of the dentists, it seems that the oldest group is the least likely to resign from their working place.

However, data showed that the middle age dentists (36-45 years) have the lower percentage of resignation compared with the oldest group in both unchanged and changed areas.

Mapping of the percentage of dentists age by group (22-28, 29-35, 36-45, 46-60 years old) by province

The percentages of dentists' ages by age group are mapped and shown in Figure 6.1 to 6.6. The mapping graph of the youngest dentists group shows that most of them are in the Northeastern region of Thailand. The distribution of this group is mostly in the bordered provinces next to Laos and Cambodia in the Northeast and Southeast regions, respectively. The younger age dentists seem evenly distributed across country. However, the graph shows that they are light in the bordered provinces in the Northeast and Southeast regions. The middle age dentists are mostly distributed in the Central and the lower part of the Northern regions, as well as the oldest dentists' group.

Figure 6.1 shows the mapping of the resignation of dentists from 2013 to 2018. Comparing the mapping graph of the resignation of dentists with the dentists' ages, the graph shows that the resignation of dentists mapping graph in Figure 6.5 is the most identical with the youngest dentists' group mapping graph in Figure 6.1. In addition, the mapping graph of the relocation of the dentists in Figure 6.6 is the most alike with the younger dentists' group in Figure 6.2.

The resignation trend by age groups in changed and unchanged areas from 2013 to 2018

Figure 6.7 shows the resignation trend of dentists in unchanged areas by age group, from 2013 to 2018. The line graph shows that the youngest dentists' group has the

Table 6.1 Rural and remote Dentist's characteristic by age groups from 2013 to 2018 n (dentists-year) (%column)

characteristics	Age22-28yrs (n=3,184)	Age29-35yrs (n=4,760)	Age36-45yrs (n=2,665)	Age46-60yrs (n=604)	P-value
Gender					
Male (3,606)	1,049(32.9)	1,546(32.5)	707(26.5)	304(50.3)	P<0.001
Female (7,607)	2,135(67.1)	3,214(67.5)	1,958(73.5)	300(49.7)	
Year of service					
1-3 years	2,892(90.8)	239(5.0)	5(0.2)	0(0)	P<0.001
4-10 years	292(9.2)	4,372(91.9)	463(17.4)	5(0.8)	
11 years ups	0(0)	149(3.13)	2,197(82.4)	599(99.2)	
Area					
Urban(2,022)	168(5.3)	1,033(21.7)	630(23.6)	191(31.6)	P<0.001
Rural(7,437)	2,522(79.2)	3,004(63.1)	1,610(60.4)	337(55.8)	
Remote(1,718)	494(15.5)	723(15.2)	425(15.9)	76(12.6)	
Region					
North(2,928)	626(19.7)	1,301(27.3)	770(28.9)	231(36.3)	P<0.001
Central(2,859)	653(20.5)	1,317(27.7)	706(26.5)	183(30.3)	
Northeast(3,270)	1,241(38.9)	1,222(25.7)	686(25.7)	121(20.0)	
South(2,156)	664(20.9)	920(19.33)	503(18.9)	69(11.4)	
Distance from hospital to the urban city in each province.					
0-20km	193(6.1)	688(14.5)	344(12.9)	112(18.5)	P<0.001
21-40km	708(22.2)	1,430(30.0)	1,045(39.2)	251(41.6)	
41-60km	960(30.2)	1,176(24.7)	658(24.7)	111(18.4)	
61km ups	1,323(41.6)	1,466(30.8)	618(23.2)	130(21.5)	

highest resignation rate, and the oldest dentists group has the lowest resignation rate. The trend of the resignation in the dentists aged 22 to 28-year-old is increasing, and dropped in 2018, while the trend of the resignation in the dentists aged 46 to 60-year-old is

constant until the trend increase in 2017. The resignation rate in-group of age 29 to 35 is lower than the youngest group but the pattern is similar. The resignation trend in-group of age 29 to 35 is increasing from 2013 but dropped in 2016 before raising again in 2017 and 2018. The resignation trend in the dentists aged 36 to 45 is alike to the oldest group but more constant. The resignation trend in the 36-45 age group is quite straight compared with the other three groups.

The graph shows that the youngest dentists have the highest resignation rate among four age groups and the oldest dentists have the lowest rate. The trend of resignation in unchanged and changed areas is quite similar, although in changed area the resignation rate is lower than in unchanged areas. The oldest dentists in changed areas also have the same scenario of the resignation trend in unchanged areas, that is quite stable from 2013 to 2017 then increasing in 2018. The overall resignation trend in changed areas is a similar pattern in unchanged areas but the rate is lower.

The trend graph in figure 6.9 and 6.10 shows the relocation rate of rural and remote dentists in unchanged and changed areas respectively. Overall, the relocation rate in changed areas is lower than in unchanged areas. In the unchanged areas, the relocation trend drops in 2017 and raises again in 2018. However, in changed areas, the relocation trend of the dentists aged 29-35 group and 36-45 group is increasing, while the trend in the youngest group decreases.

The triple differences regression analysis in resignation and relocation of dentists in changed and unchanged areas by age groups

The regression results of the resigned dentist and dentists' age in changed areas after the policy implementation and other related factors in Table 3.1 shows that after the

Table 6.2 Rural and remote Dentist's location status by age groups in unchanged and changed areas from 2013 to 2018

Location status	Age22-28yrs (n=3,184)	Age29-35yrs (n=4,760)	Age36-45yrs (n=2,665)	Age46-60yrs (n=604)
Resign	341(14.6)	144(5.4)	24(2.0)	12(5.2)
Relocate_urban	64(2.7)	96(3.6)	21(1.8)	6(2.6)
Relocate_ rural	88(3.8)	135(5.1)	33(2.8)	6(2.6)
Stay	1,847(78.9)	2,287(85.9)	1,117(93.5)	208(89.7)
Resign	127(14.0)	135(6.1)	34(2.3)	15(4.0)
Relocate_urban	2(0.2)	21(0.9)	7(0.5)	1(0.3)
Relocate_ rural	26(2.9)	45(2.0)	21(1.4)	3(0.8)
Stay	755(83.0)	2,014(90.9)	1,436(95.9)	360(95.0)

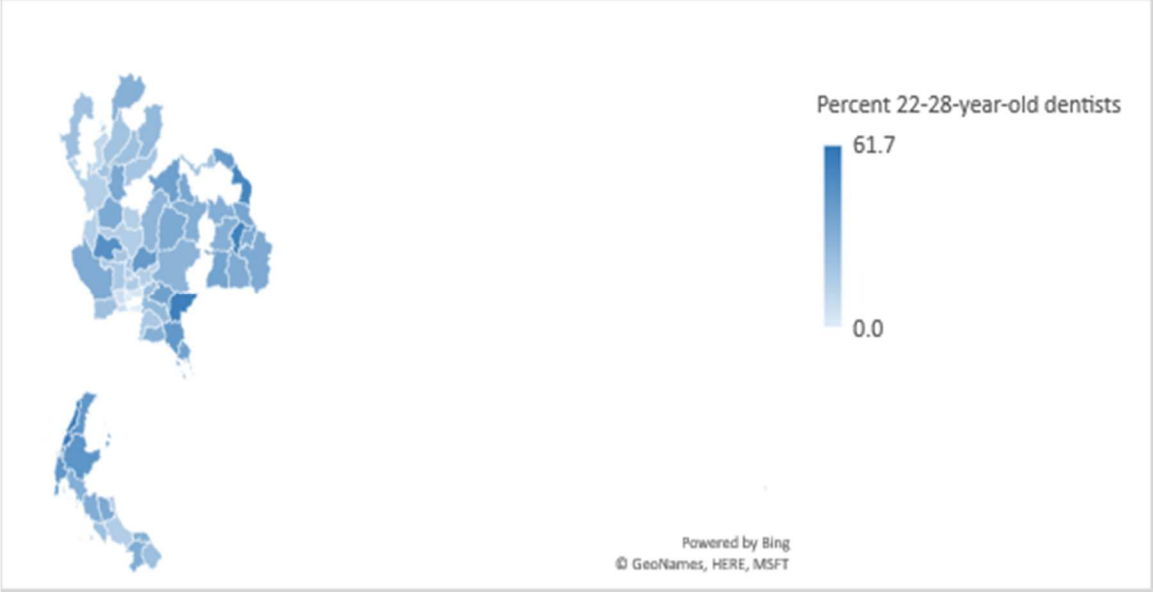

Figure 6.1 Mapping graph of percent of dentists age 22-28-year-old by province from 2013 to 2018

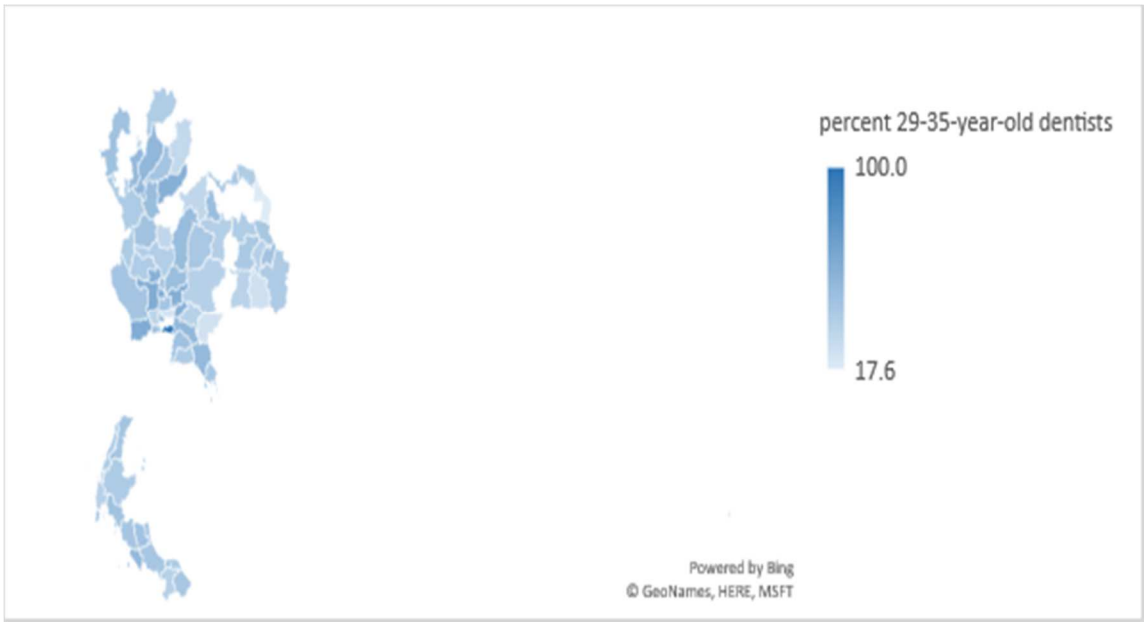

Figure 6.2 Mapping graph of percent of dentists age 29-35-year-old by province from 2013 to 2018

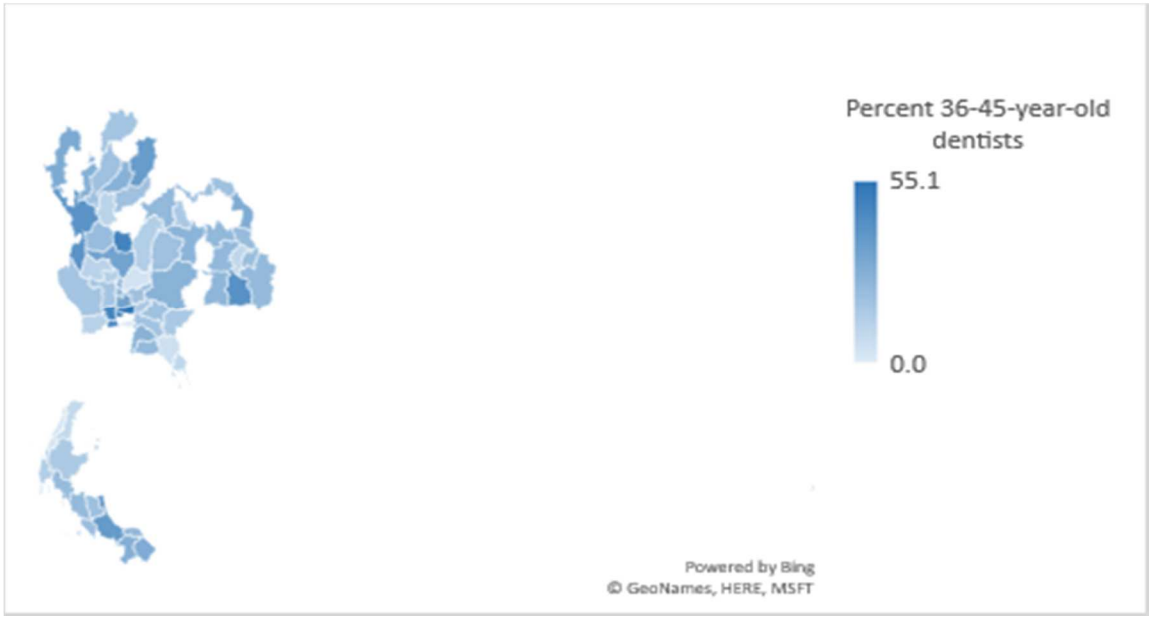

Figure 6.3 Mapping graph of percent of dentists age 36-45-year-old by province from 2013 to 2018

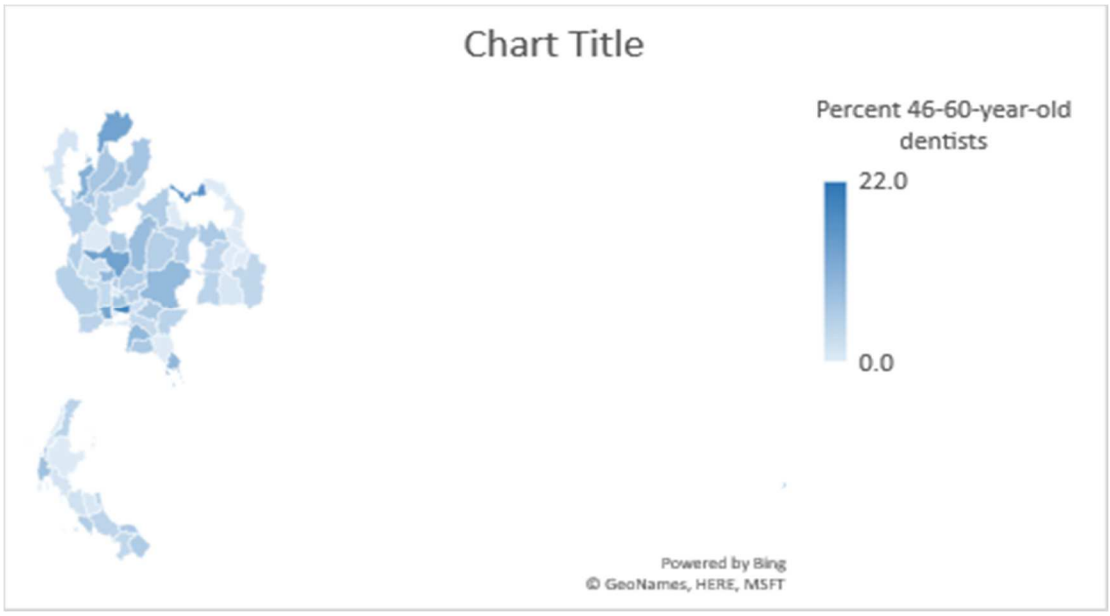

Figure 6.4 Mapping graph of percent of dentists age 46-60-year-old by province from 2013 to 2018

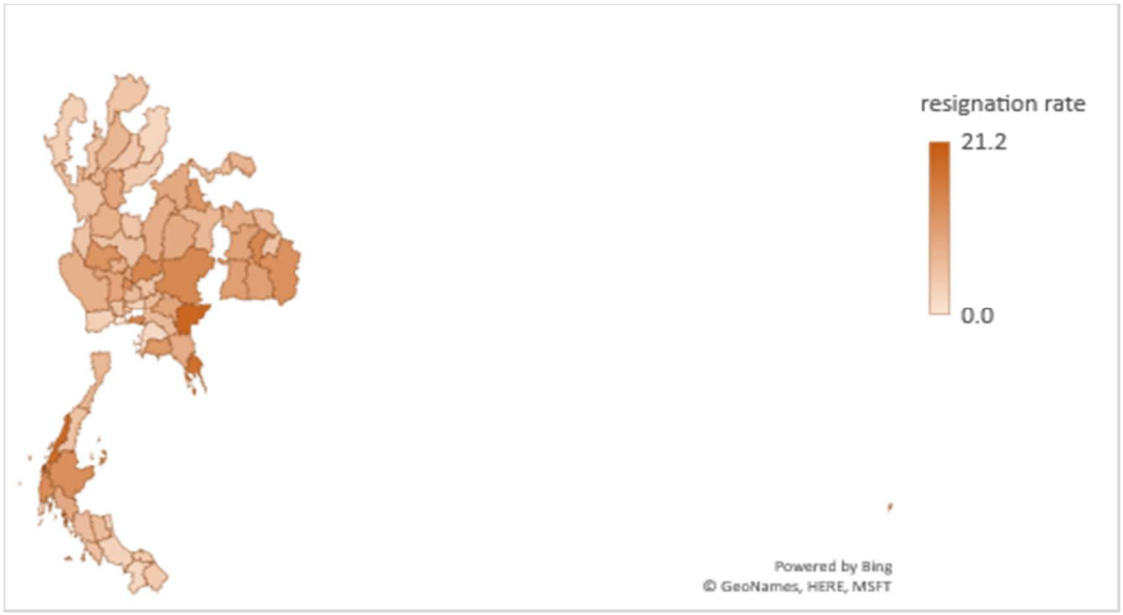

Figure 6.5 Mapping graph of resigned dentists by province from 2013 to 2018

Figure 6.6 Mapping graph of relocated dentists by province from 2013 to 2018

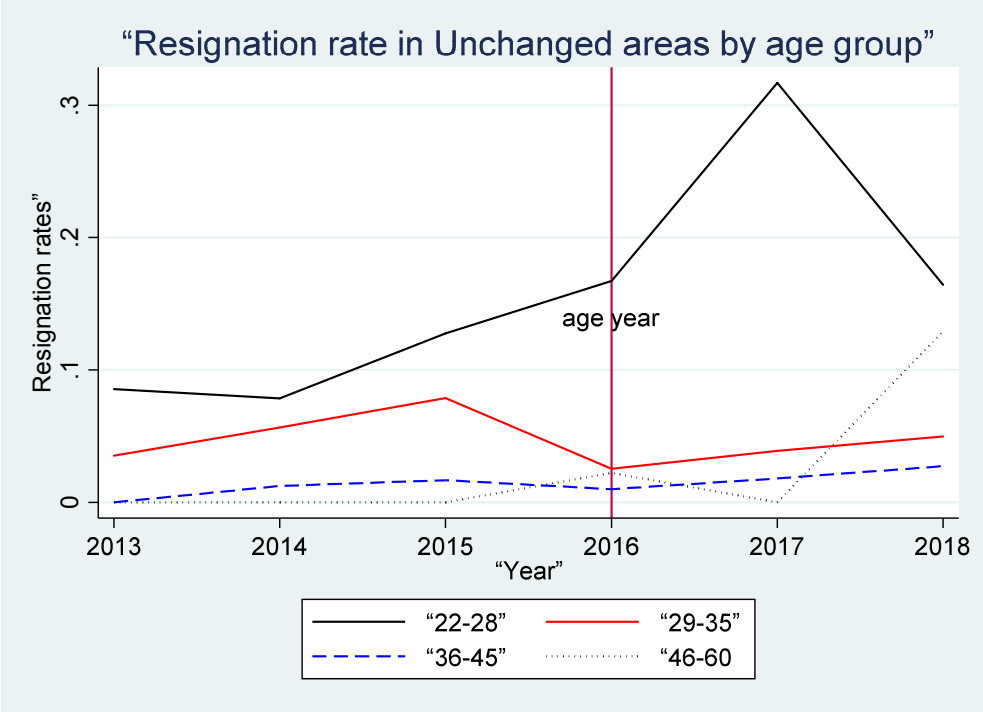

Figure 6.7 The trend graph show the resignation rate of dentists in unchanged areas from 2013 to 2018

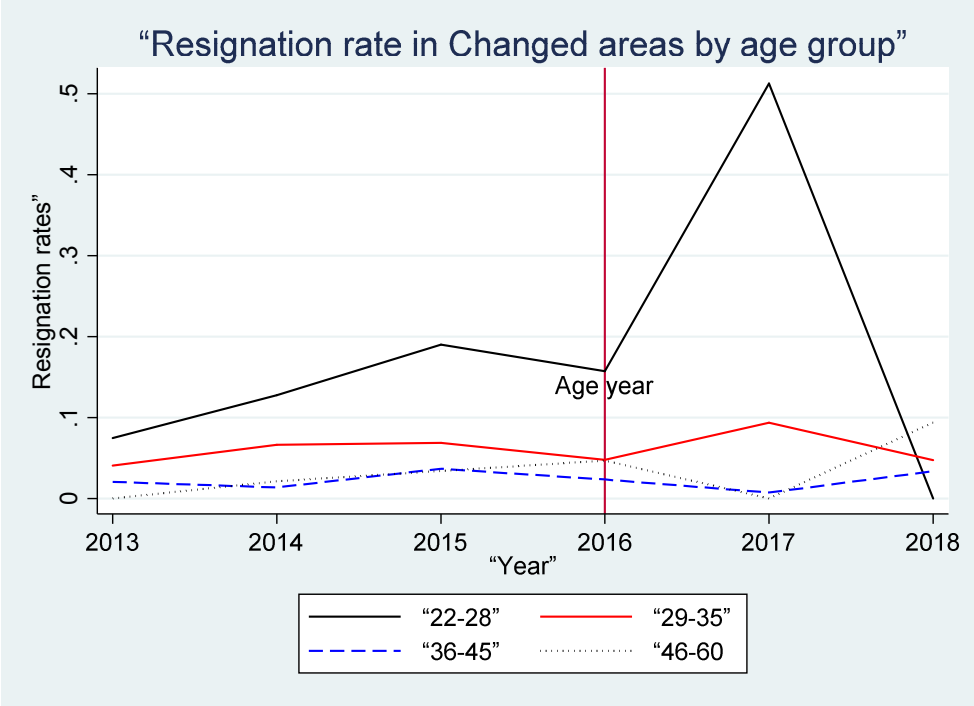

Figure 6.8 The trend graph show the resignation rate of rural and remote dentists in changed areas from 2013 to 2018

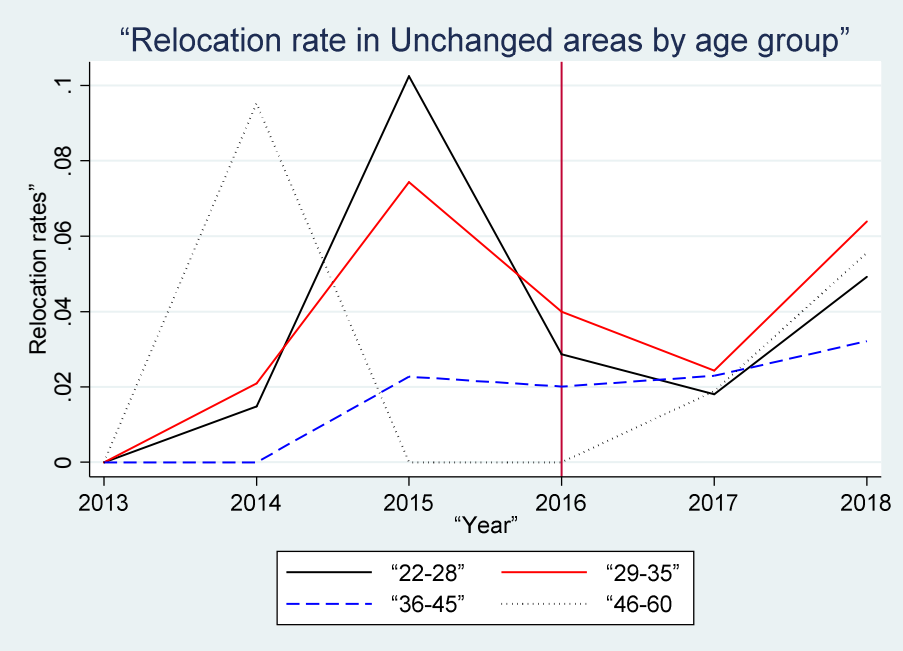

Figure 6.9 The trend graph show the relocation rate of rural and remote dentists in unchanged areas from 2013 to 2018

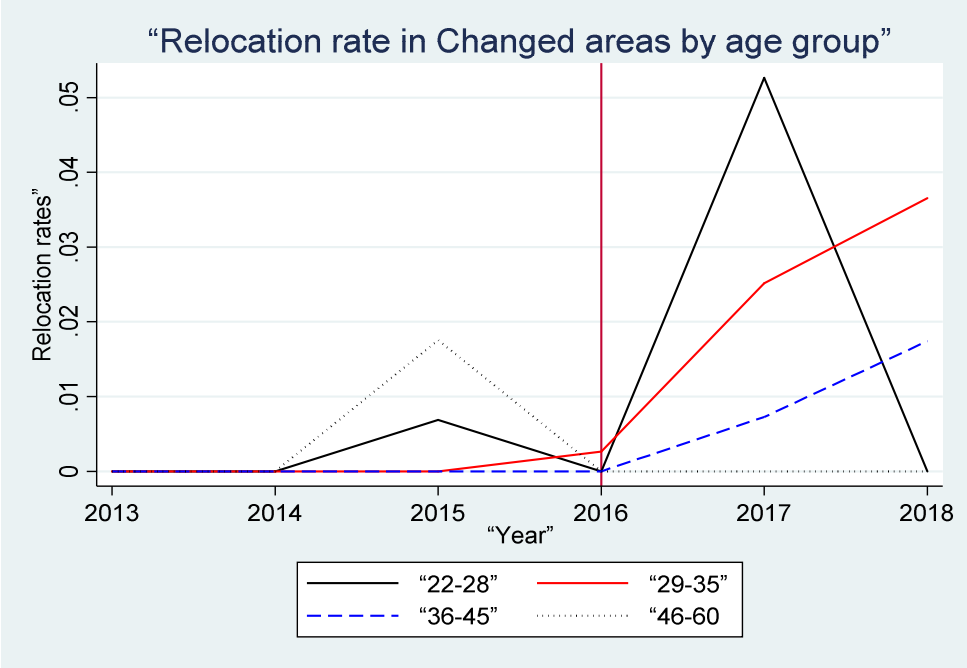

Figure 6.10 The trend graph show the relocation rate of rural and remote dentists in changed areas from 2013 to 2018

policy implementation the resignation dentists are more likely to increase significantly although the resignation of dentists in unchanged and changed areas is no different. Among four age groups, it is found that the youngest group are the most likely to resign from the MoPH facilities compared with the other three groups. It is found that the higher age the dentist is, the less likely to resign from their location in rural and remote areas, significantly. In addition, the resignation of dentists after December 2016 in the youngest group is the highest among four groups. The younger group (29-35) and the middle group (36-45) are less likely to resign significantly compared with the youngest group (22-28), although the oldest group (46-60) is less likely to resign insignificantly after the policy implementation, compared with the other three groups.

The regression analysis shows that in the changed areas after the policy implementation in December 2016, the oldest dentists' group (46-60) is the less likely to resign from their location practice significantly compared with the youngest group (22-28). Data shows there is no difference of resignation between male and female dentists. But resignation of rural and remote dentists by region shows that dentists in the North and South regions are less likely to resign significantly, compared with the Northeast dentists.

Nevertheless, the data shows that the distance between the dentists' working location and the urban city in each province affected the decision of dentists to resign. It is found that dentists who were located the furthest away are less likely to resign significantly. Data shows that the further away the dentists were located, the less likely they resigned from their working place. The regression of the relocation to urban areas of dentists, with dentists' age and other related factors shows in Table 6.4. Although there is no different of the resignation of dentists in unchanged and changed areas, the dentists' relocation to urban in changed areas is less than in unchanged areas significantly, while the relocation of dentists after the policy implementation is less likely to increase insignificantly.

The relocation data of dentists shows that the oldest group is the less likely to relocate among four age groups followed by the middle age group (36-45). On the other hand, the younger dentists(29-35) are also more likely to relocate to urban areas compared with the youngest dentists insignificantly.

In the unchanged and changed areas, data showed that the relocation of dentists in each of the four age groups is not different. In addition, it is found that before and after

the policy implementation in December 2016, there is no significant difference of dentists' relocation in all age groups. Furthermore, in changed areas after December 2016, the oldest groups are less likely to relocate the most, followed by the middle groups and the younger group insignificantly compared with the youngest dentists.

The relocation of male and female dentists is no difference, as well as the resignation of male and female dentists. However, the relocation to urban areas by dentists in the North and the Central regions is increasing significantly compared with dentists in Northeast region. Furthermore, the relocation of dentists who are located close to the city are more likely to relocate to urban city significantly.

Table 6.4 shows the regression of the resignation and the relocation to urban areas of dentists with dentists' age and other related factors. The statistics shows that the dentists' resignation and the dentists' relocation to urban areas combined is likely to decrease significantly in changed areas. In contrast, the resignation and the relocation of dentists are more likely to increase after the policy implementation in 2016. As well, the resignation and relocation of dentists in changed areas after the policy implementation are more likely to increase significantly. The youngest dentists are more likely to resign and relocate the most among four age groups, as well as the oldest dentists are less likely to resign and relocate the most significantly. Data shows that the younger the dentist is, the more likely to resign and relocate to urban areas.

It is found that there is still no significant difference of resignation and relocation of dentists between unchanged and changed areas in all age groups, except that the younger dentists are less likely to resign and relocate compared with the youngest. But after the policy implementation in December 2016, the resignation and relocation

rate of the younger dentists(29-35) and the middle groups(36-45) decreased significantly compared with the youngest dentists' groups.

The data analysis shows that in the changed areas after the policy implementation in December 2016, the oldest dentists are less likely to resign and relocate significantly compared with the youngest dentists, followed by the middle-aged dentists. Nonetheless, the male and female dentists still have no significant difference of resignation and relocation to urban areas.

It is found that the resignation and relocation of dentists in the Central region is not different compared with the dentists in the Northeast region. However, the dentists in the North and South regions are less likely to resign and relocate significantly. Moreover, data shows that dentists who are located in the areas close to the city (0-20km., and 21-40km.) are more likely to resign and relocate significantly compared with the dentists who are located the furthest from the urban city.

Discussion

The study aims to determine the relationship between dentists' age and their decision to leave or stay in rural and remote areas after the HA payment reduction, due to the December 2016 policy of recategorized the HA location areas. The finding shows that dentists' age is related with dentists' location choice. The regression analysis shows that the oldest group (46-60) is less likely to resign compared with the youngest dentists significantly. Therefore, the youngest group is the more likely to leave the practice location in the changed areas after the policy implementation. Although, the finding is opposite from the study's hypothesis, it is not surprised.

Table 6.3 Regression analysis on resignation of dentists and changed areas and age after policy implementation

		Resignation	**Relocation**	**Resignation &relocation**
Intercept		.257**(.014)	.017**(.005)	.235**(.140)
Post(after2016)		.161**(.014)	-.011(.009)	.160**(.046)
Ruraltourban		.012(.014)	-.056**(.006)	-.082**(.017)
Post.ruraltourban		.064(.039)	.058(.030)	.129**(.006)
Age (ref. 22-28 year-old)	29-35year-old	-.027**(.009)	.001(.005)	-.037**(.011)
	36-45year-old	-.073**(.014)	-.025**(.006)	-.112**(.016)
	46-60year-old	-.119**(.031)	-.024(.013)	-.169**(.035)
Rualtourban.age (ref. 22-28 year-old)	29-35year-old	-.025(.014)	-.013(.008)	-.041**(.017)
	36-45year-old	-.002(.021)	.015(.009)	-.002(.024)
	46-60year-old	.034(.039)	.013(.018)	.047(.046)
Post.age (ref. 22-28year-old)	29-35year-old	-.107**(.017)	.010(.011)	-.129**(.019)
	36-45year-old	-.127**(.019)	.022(.012)	-.123**(.022)
	46-60year-old	-.051(.030)	.021(.021)	-.044(.037)
Rualtourban.post.age (ref.22-28 year-old)	29-35year-old	-.041(.042)	-.026(.032)	-.053(.049)
	36-45year-old	-.080(.043)	-.057(.032)	**-.132**(.051)**
	46-60year-old	**-.128**(.053)**	-.073(.038)	**-.205**(.063)**
Gender(ref.male)				
female		-.012(.012)	-.0004(.003)	-.012(.011)

Region (ref. NE)			
North	-.080**(.014)	.009**(.004)	-.039**(.014)
Central	-.027(.014)	.009**(.004)	.006(.014)
South	-.062**(.015)	-.005(.004)	-.058**(.016)
Distance from hospital to urban(ref. 60 km up)			
0-20km	-.045**(.014)	.108**(.005)	.183**(.016)
21-40km	-.041**(.013)	.038**(.004)	.047**(.014)
41-60km	-.031**(.012)	.016(.004)	.003(.013)
R-sq within	.011	.111	.035
R-sq between	.144	.084	.108
No. of observation	11,213	10,381	11,213
No. of groups	2,384	1,975	2,384
Sigma_u	.242	0	.229
Sigma_e	.181	.135	.223
Rho	.641	0	.513

Prior evidences provide the indecisive conclusion whether health workers' age related with the health workers' location choice (Lehmann, 2008; Ruston, 2012). However, our study's outcomes show that the youngest dentists are more likely to leave their location when the financial incentive reduction. The outcomes of the study differ from the study' hypothesis that the older aged dentist who affects the reduction of HA the most, should be more likely to leave the practice location. Although, the outcomes of the study contrast with our assumption, the outcomes correspond with several articles (Wang,

2013; Antwi, 2013). For example, the study to explore the poor recruitment of physicians to rural areas in Beijing found that generally physicians who practice in rural areas were older than the average age of all physicians (Wang, 2013).

Nonetheless, our outcomes are different from several findings which showed that the younger health workers were more likely to remain in rural and remote areas (Lexomboon, 2003; Richards, 2005; Ebuehi, 2011). For example, Lexomboon (2003) found that the young experience dentists were more likely to remain in the rural and remote areas. The author explained that the young dentists who serve for 1 to 3 years have the compulsory service contract with the government. The contract could keep them in their practice location at least 3 years. The more year they served, the more likely to leave their location. However, our study shows that the young dentists are more likely to leave their location.

The reason of the different results of our study and Lexomboon's maybe due to the low value of the payout rate of dentists who leave before completing the mandatory service. Since 1989, the government implemented the compulsory service policy for retaining new dentists working in community hospitals especially in rural and remote areas. The payout rate of punishment any dentists who could not complete the mandatory service within three year, have not been changed since the policy implementing. At the present, the rate has been reduced by the value of money reduced. Therefore, there are more young dentists decide to resign and payout at the current data set.

In this study, we classified the dentists' age into 4 groups. The youngest was aged from 22 to 28 years old. Most dentists in this group had working experience of 1-3-year. The outcomes of our study show that this youngest group is the most likely to leave from

their practice location. We will explain the reason for the resigning of the youngest groups following these. First, the youngest groups mostly recruit to serve in the very rural areas in the Northeast region, as shown in the mapping graph. Some of them who are of urban origin cannot adjust to work in those rural locations and decide to leave (Wilson, 2009). However, every new dentist must serve at least two years before getting permission to relocate. Therefore, many of them decide to resign instead of waiting for the relocation permission. Second, the payout of punishment dentists who could not serve at least three years is the same rate which is not high compared with the income from the private sector (Wilbulpolprasert, 2003). Many young dentists who come from the affordable family could payout and resign from the MoPH. Third, the youngest group who have no spouse or kid are more flexible to resign or relocate compared with the older group. In addition, these young dentists have less relationship with the working place and community which made them decide to leave easier than the senior group who are accustomed with working and living in rural and remote communities.

On the other hand, the oldest dentists are the less likely to leave from their practice location. There are several reasons could be explained this situation. First, there are several monetary supplements for dentists working in MoPH, for instance, the non-private fee, the professional fee, etc. These supplements may be enough for motivate these groups to remain in their practice location despite the HA reduction (Wilbulpolprasert, 2003; Henderson, 2008). Second, the oldest dentists who settle in that areas, which make them get used to with their location areas. They have family, friend, and good relationship with the communities (Wilson, 2009; Buykx, 2010). The reduction of the HA payment could not motivate them to leave their areas. In addition, this dentists

group have no financial burden for family or children and free of financial issues. They choose to remain in the communities that make them happy rather than making more money.

The findings that the oldest group is less likely to resign from their practice location despite the reduction of the financial incentives. This outcome demonstrates that financial factor is not only factor that motivate dentists' location choice. The non-financial factor such as age which is the personal factor also affects the decision of dentists choosing to leave or stay in rural and remote areas. This finding supports the concept of the integration of the financial and non-financial factors to motivate health workers working in rural and remote areas (Henderson, 2008; Humphrey, 2009). Besides the personal factors, there are many non-financial factors which significant influence the health worker location choice. Non-financial factors are also including family aspect, working and living conditions, career aspects, professional and personal support (WHO, 2010). Our findings which show the relationship of dentists' age and dentists' location choice demonstrate the significant of the non-financial incentives. There are many non-financial incentives which required more study to investigate.

Conclusion

In conclusion, dentists' age is related with the dentists' decision to stay or leave rural and remote areas when the HA reduction. Although, the policy implementation caused the financial incentive reduction, most of the oldest group decide to stay in their practice location. Therefore, financial incentive may be not the only factors influence dentist decide to stay or leave rural and remote areas.

Limitation

The data source of this study is obtained from the annual report of Human resource management which contained a few variables. There are some variables unavailable from the data set. For examples, variables which related with the non-financial incentives is not included in the annual report. Based on the conceptual framework showed the factor related to the decision of dentists to leave or stay in rural and remote areas involved with financial and non-financial factors. However, the observational data is contained mostly the financial factor variables and some personal characteristics of dentists. Therefore, the outcome shows the restricted evidence to analyses and discuss to complete to theoretical concept.

CHAPTER 7

CONCLUSION

This dissertation consists of 3 specific aims. Study Aim#1 is to examine the effectiveness of the direct payment financial incentive called HA, on retaining dentists in rural and remote areas. The difference in difference regression on resignation rates of dentists in response to the HA in 2008. It can be concluded that the HA direct payment is a significant factor to retain health workers in rural and remote areas. The outcome of the study shows that direct payment financial incentives affect the resignation rate of dentists in rural and remote areas. This study does not measure the retention rate of dentists directly. However, the decreasing of resignation rate after the 2008 financial incentive program implementation demonstrates that financial factors could retain dentist in rural and remote areas.

Study Aim#2 is to examine the effect of HA reduction on dentists' location choice. In December 2016, the government recategorized the HA areas; as a result, some rural areas became urban areas and the HA decreased by the area changing. From the different in different regression with fixed effect estimation on dentists' resignation and relocation in response to the changed areas after the policy implementation in December 2016, it can be concluded that the HA reduction is influencing dentists to relocate from their practice location. Although the resignation of dentists is not significantly different in changed areas after the policy implementation, the combination of the resignation and

relocation of dentists can infer that dentists are more likely to leave the practice location when the HA is reduced.

Study Aim#3 is to examine the relationship of dentists' age and dentists' location choice when the HA is reduced. This is because the HA payment criteria depends on the areas (urban, rural, and remote areas) and year of service (1-3, 4-10, and over 11 years). It is assumed that besides practice location, age should be another essential influence for dentists' decisions to stay or leave their rural communities. From the triple difference regression with random effect estimation on dentists' resignation and relocation in response to dentists' age and changed areas after the policy implementation in December 2016, it can be concluded that dentists' age is related to the location choice. It found that the oldest dentists (46-60) is the less likely to leave their location practice where the HA is reduced, compared with the youngest group.

Although the observational retrospective data which we obtained has a limitation to provide the retention rate data, the resignation rate which is used in the study can illustrate the effectiveness of HA direct payment financial incentives. Nevertheless, the data is insufficient to reveal the extent of dentists remaining in rural and remote areas. The study can show the effect of HA payment on dentists' location choice when either the HA increases or decreases.

The responses of dentists' decisions to stay or leave rural areas based on the HA direct payment both in positive and negative ways show that the financial factor is the essential factors on health worker's location choice. However, the study shows that financial incentive is not only factor which influences health workers' decision. At least,

personal factors such as health workers' age are also key factors on health workers' location choice.

It can conclude that the outcome of the study is consistent with the utility theory. Based on the utility theory, it is assumed that health workers choose practice locations which maximize their utility. The utility function includes financial and non-financial factors. Therefore, to develop the efficient strategies to address the disparity distribution of health workers, the policy maker should integrate both financial and non-financial incentives. Moreover, to conduct an efficient study to evaluate the effectiveness of the program, the researcher should create the effective method to collect and record adequate and quality information for optimal analysis.

Lessons learned from the study

The government have to consider how age of dentists relates with the decision to leave or stay in rural and remote areas. The outcome shows that the HA payment reduction did not affect the oldest dentist group to resign or relocate their location compared with the youngest group. This demonstrates that if the government have the budget constraint and the high resignation rate problem still exist. The effective strategy to retain dentists working in rural and remote areas including increase financial incentive to the youngest group while reduce the payment rate to the oldest group.

In addition, the government should implement other non-financial incentives strategy which evidence show the relationship to health workers' location choices. For example, improving the working and living condition or provide more opportunity to continuing education to attract the young dentists' group to stay longer in their practice location. Because the evidence shows that these factors affected the health worker to

leave or stay in rural and remote areas especially for dentists in Thailand (Lexomboon, 2003). In addition, the results from the difference in difference regression with fixed effect analysis in Aim#2 shows that the distance between the practice location and the urban city related with the resignation and relocation of the dentists. The outcome for Aim#2 also demonstrated that the changed areas which have more amenities such as commercial banks, private clinics, convenient stores, etc., are more attractive compared with the unchanged areas. The finding shows that the dentists in the changed areas area less likely to resign or relocate to their location practice.

The most important thing is the government should evaluate all the strategies that were implemented to improve the disparities distribution of dentists and other health professionals, including the educational strategies, the compulsory services, the financial and non-financial incentives programs. Besides, to improve the efficiency of the programs, persistently evaluating the program could prevent new issues. This is because the increasing of the dentists from the educational and compulsory service policy might cause the oversupply of dentists. However, the dentists still continuously resign or relocate from the unpleasant places in rural and remote areas. Therefore, the government have to create another policy to address the oversupply of dentists in urban and some attractive rural areas, and the undersupply in some unpleasant rural and remote areas.

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APPENDIX A

THE TABLE OF THE COMMUNITY HOSPITALS UNDER THE MOPH BY HA AREAS BY PROVINCES WHICH ATTACHED IN THE NOTIFICATION OF MOPH ON SEPTEMBER 5, 2013

HR	Province	Hospitals					
		Urban	Suburban1	Suburban2	Rural	Remote1	Remote2
1	Chiangrai			Teang Pan Maechan Maesai Weingpapao	Khuntan Chiansan Padad Payamengrai Maelao Maesaui Weingchiangrung Somdetpayansangworn Doiluang	Chiangkong	Maefahluoung Wiengkan
	Nan			Pua	Chiangklang Tawangpa Maecharim Wiengsa Pupieng	Tungchang Nanoi Nameaun Banluang Songkaew Santisuk	Bokleau Chalermpakiet
	Payao				Chun Dokkamtai Pong Maechai	Chiangmuan	

HR	Province	Hospitals					
		Urban	Suburban1	Suburban2	Rural	Remote1	Remote2
1	Phrae			Denchai	Rongkwang Long Wangchin Song Sungmen Nongmuangkai		
	Chiangmai	Chomthong Fang	Hangdong	Sanpatong	Chiangdao Chaipakan Doisaket Doilor Prao Maetang Maewang Maeon Sameang Sankampang Sansei Sarapi Hod	Doitao Maeeai	Wianghang Aomgoi Watchan Maecham
	Maehongson					Pai Maesariang	Kunyaum Pangmapa Maelanoi Sobmeui
	Lampang			Koka Teon	Ngao Chaehom Mueangpan Maeta Maemo Wangneau	Maeprik	

HR	Province	Hospitals					
		Urban	Suburban1	Suburban2	Rural	Remote1	Remote2
1	Lampang				Sobprab Sermngam Hangchat		
	Lampoon				Banti Banhong Pasang Maetar Wiangnonglong	Li	Tunghuachang
2	Tak				Bantak Samgnao	Pobpra Maelamad	Tasongyang Unpang
	Pitsanulok				Neonmaprang Bangkratum Bangrakam Prompiram Wangtong Watboad	Nakorntai Chattakan	
	Petchabun		Wichianburi	Nongpai Lomsak Lomkao	Chondan Buengsampan Wangpong Sitep	Kaokor	Namnao
	Sukothai				Kongkailad Kirimad Tungsalium Bandanlanhoi Sinakorn Sisatchanalai Sawankalok		
	Uttaradit			Nampad	Tron Tongsankan	Fakta	Bankok

HR	Province	Hospitals					
		Urban	Suburban1	Suburban2	Rural	Remote1	Remote2
2	Uttaradit				Tapla Pichai Lablae		
3	Chainat				Manorom Wasting Sankaburi Sanpaya Hanka		
	kampangpet			kanuworakburi	Klongklung Klonglan Saitongwatana Tungpotalay Saingam Buengsamaki Prankatai Lankabue	Pangsilatong	
	Pichit			Bangmunnak Tapanhin	Tabklor Potalay Popatabchang Wachirabarami Wangsaipun Samngam		
	Nakornsawan			Chumsang Takli Tatako Ladyao	Kaoliao Krokpra Takfa Banpotpisai Payuhakiri Pisali Nongbua	maewong	

HR	Province	Hospitals					
		Urban	Suburban1	Suburban2	Rural	Remote1	Remote2
3	Uthaitani				Tabtan Banrai Lansak Sawangarom Nongkayan Nongchang Houikot		
4	Nontaburi	Bangkrau Bangbua_t Bangyai Pakgred			Sainoi		
	Patumtani			Tanyaburi	Klongluang Pachatipat Ladlumkeaw Lamlukka Samkok Nongseau		
	Ayuthaya				Tareau Bangsai Bangsi Bangban Bangpahan Bangpain Banpreak Pakhai Pachi Maharat Ladbualuang Wangnoi		

HR	Province	Hospitals					
		Urban	Suburban1	Suburban2	Rural	Remote1	Remote2
4	Ayuthaya				Somdetprasankarat Uthai		
	Saraburi				Kangkoi Donpud Banmor Muaklek Wangmoungsatatam Wihandang Saohai Nongkae Nongsang Nongdone		
	Lopburi			Koksamrong Chaibadan	Kokchareon Tawung Taluang Patananikom Lamsonti Saboad Nongmoung		
	Singburi				Kaibangrachan Tachang Bangrachan promburi		
	Angtong			Wisetchaichan	Chaiyo Pamok Potong Samko Sawangha		

HR	Province	Hospitals					
		Urban	Suburban1	Suburban2	Rural	Remote1	Remote2
	Nakornnayok				Banna Pakpli Ongkarak		
5	Kanchanaburi			Tamoung Boploy	Chaokunpaibunpanom_t Danmakamtia Takadan Saiyok Laokwan Huaikachao	Tongpapum Suksirisisawat Satanpabarami somdetpapiyamarat	Sangkaburi
	Ratburi			Chombueng	Chetsamien Bangpae Paktor Watpleng Suanpeung		
	Supanburi			Danchang Utong	Donjedee Dermbangnangbuad Bangplama Sipachan Samchuk Nongyasai		
	Pachaupkirikan			Bangsapan	Kuiburi Bansapannoi Pranburi Samroiyod		
	Petburi			Chaum	Kankachan Kaoyoi Tayang		

HR	Province	Hospitals					
		Urban	Suburban1	Suburban2	Rural	Remote1	Remote2
6	Petburi				Banlad Banlam Nongyaplong		
	Samutsongkram			Napalai	Ampawa		
	Chacheonsao			Bangnampreau Bangpakong Panomsarakam Sanamchaiket	Bangkla Banpo Planyao Ratchasan	Tatakieb	
	Prachinburi	Kabinburi			Nadi Bansang Pachantakam Simahapo Simahosot		
	Sakeaw	Aranyapatet			Kaochakan Klonghad Wangnamyen Watananakorn	Tapaya	
	Samutprakan	Banchak Banbo Banpli			Pasamutchedisawatyanon		
	Chantaburi				Kanghangmaew Klung Kaokitchakut Kaosukim Tamai Nayaiarm Pongnamron Makham		

HR	Province	Hospitals					
		Urban	Suburban1	Suburban2	Rural	Remote1	Remote2
	Chantaburi				Songpinong Soidao Lamsing		
6	Chonburi	Banglamun g Banbueng Panasnikom Aoudom			Kosichan Botong Pantong Watyannasanwararam Satahieb Nongyai		
	Trad				Kaosaming Klongyai Lamngob	Kochang	Kokud
	Rayong	Klang Mabtapud		Banchan	Kaochamao Nikompattana Bankai Plaugdang Wangchan		
7	Kalasin			Yangtalad Somdet Kuchinarai	Kamalasai Kammuang Namon Rongkam Sahasakan Nongkungsi Huaipueng Huaimeg	Takanto Kaowong	
	Khonkan	Chumpae		Nampong	Kaosuankwang		

HR	Province	Hospitals					
		Urban	Suburban1	Suburban2	Rural	Remote1	Remote 2
7	Khonkan			Banpai Pon Kanoun	Chonnabot Samsung Banfang Peaunoi Prayean Pupaman Puwieng Manchakiri Wangnoi Wangyai Sichompu Nongreau Nongsonghong Ubonrat		
	Mahasarakam			Borabue Payakpupisai	Kantarawichai Kaedam Kosumpisai Chiangyean Nacheuk Nadun Wapipatum	Yangsisurat	
	Roiet			Ponetong Suwannapum Selapum	Kasetwisai Chaturapakpiman Chanhan Tawatburi Patumrat Panompai Pochai	Meyawadee	

HR	Province	Hospitals					
		Urban	Suburban1	Suburban2	Rural	Remote1	Remote 2
8	Roiet				Ponesai Muengsuong Sisomdet Nongpok Artsamat		
	Buengkan				Sopisai Pakkad Pornchareon Siwilai	Seka Buengkonglo n Bungkla	
	Loei				Chiangkan Tali Naduang Pukadueng Pureau Wangsapung Arawan	Dansai Pakchom Puloung Pakao	Naheaw
	Nongkai			Tabor	Ponepisai Sichiangmai Sakai	Sangkom	
	Nongbualampu				Naklang Nawang Nonesang Sibunreang	Suwankuha	
	Udontani	Kumpawapi		Banpeu Pen Nonghan	Kudchab Chaiwan Tungfon	Nayoon Namsoam	

HR	Province	Hospitals					
		Urban	Suburban1	Suburban2	Rural	Remote1	Remote 2
	Udontani			Bandung	Nonesaard Pibunrak Wangsammor Sitat Sangkom Nongwausar Nongsang Huaikeang		
8	Nakornpanom			Sisongkam Tatpanom	Tauten Nakae Nawa Banpang Plapak Ponesawan Renunakorn Wangyang	Natom	
	Sakonnakorn	sawangdindang		Wanornniwas	Kudbak Kusuman Kamtakla Koksisupan Chareonsin Taongoi Banmuang Paarchanban Paarchanphun Pungkone Ponnakeaw Waritpum	Nikomnamun	

HR	Province	Hospitals					
		Urban	Suburban1	Suburban2	Rural	Remote1	Remote 2
8	Sakonnakorn				Songdao Akartamnoui		
9	Chaiyapum			Kangkor Bamnetnarong Pukieu Nongbuadang	Kasetsombun Kornsawan Kornsan Chasturas Tepsatit Neonsanga Bankewa Bantan Nongbuaraheal Subyai	Pakdichumpo n	
	Nakornratchasi ma	Pakchongnana Teparat	Pimai	Kornburi Chakarat Chumpoung Chokchai Dankuntod Buayai Patai Paktongchai Sikew Sungneon	Kangsanamnan Kamtalaysor Kamsakaesang Kong Nonedang Nonetai Nonesung Banleaum Patongkam Lamtameinchai Wangnamkiew Seangsang Nongbunnak Huaitalang Bualai Teparak	Somdetya_my	

HR	Province	Hospitals					
		Urban	Suburban1	Suburban2	Rural	Remote1	Remote 2
9	Nakornratchasima				Sida Chalermpakiet		
	Buriram	Nangrong		Pakonechai Puttaisong Lahansai	Kasang Cumuang Candong Chalermpakiet Chamni Napoe Nonesuwan Bankruad Banmaichaipot Pacam Pubplachai Nongki Nonghong Huairat		
	Surin	Prasat		Tatum Ratanaburi Sikarapum Sangca	Kabcheang Chompa Chumponburi Buached Lamduan Sanom Samrongtab	Panomdongrak	

HR	Province	Hospitals					
		Urban	Suburban1	Suburban2	Rural	Remote1	Remote2
9	Surin				Nonenarai Kewasirin Sinarong		
10	Mukdahan				Kamchaee Dontan Nikomkamsoi Wanyai	Dongluang Nongsung	
	Yasotorn			Leangnokta	Kudchum Korwang Kamkeankeaw Saimoon Thaichareon Patew Mahachaichano		
	Sisaket		Kantararak	Kukun Kunhan Rasisalai Utumpornpisai	Kantrarom Buengbun Bencharak Prangku Pribueng Yangchumnoi Wanghin Sirattana Huaitabtan	Namkliang Nonekoon Pusing Muangchan	
	Ubonratchatani	Mahawachira Warinchamrab Detudom		Takanpeadpon Pibunmangsahan	Kudkaopun Kemmarat Kuangnai Kongcheam Donmoddang	Namyean Buntarik Poesai	Nachaluai

HR	Province	Hospitals					
		Urban	Suburban1	Suburban2	Rural	Remote1	Remote2
10	Ubonratchatani				Tansum Tungsiudom Moungsamsib Simuangmai Samrong Sirintorn Natan Nayia Namkun Nayia Laosuaukok		
	Amnartchareon				Patumratwongsa Pana Lueamnart Senangkanikom Huatapan	Chanuman	
11	Chumporn			Lungsuan	Tungtaco Patew Paknamchumporn Paknamlungsuan Tasae Mabammarit Lamae Sawee	Patoh	
	Nakornsitammarat	Tungsong Sichon		Tasala Pakpanung Ronpibul Chawang	Kanom Chulaporn Chauad Chienyai	Tampannara Bangkun Pipoon	

HR	Province	Hospitals					
		Urban	Suburban1	Suburban2	Rural	Remote1	Remote2
					Tungyai Nabon Promkiri Lansaka Huasai		
	Surattani			Kanchanadit Tarongchang Bannasan Wiengsa	Kiriratniyom Kiensa Chaiya Donsak Tachang Tachana Bantakun Bannaderm Panom Prasang Punpin	Kopangan Chaiburi Wipawadi	
	Krabi				Kaopanom Klongtom Plaipaya Lamtub Neauklong Aoleuk		Kolanta
11	Pangnga				Kaponchaipat Takuatung Tubpud Taimuangchaipat Bangsai	Kuraburichaipat	Koyaochaipat

HR	Province	Hospitals					
		Urban	Suburban1	Suburban2	Rural	Remote1	Remote2
11	Phuket	Patong Talang					
	Ranong				Kaburi Kaper	Laun Suksamran	
12	Pattalung			Kuankanun	Kaochaison Tamoad Bangkeaw Pakpayoon Pabon Papayom Sibunpot Sinakarin	Kongrha	
	Trang			Huaiyod	Kantrang Nayong Palien Yantakao Ratsada Wangwiset Sikao Hadsamran		
	Naratiwat						Ranhae Lueseau Yinhor Chanae Cheairong Takbai Bachea Wang

HR	Province	Hospitals					
		Urban	Suburban1	Suburban2	Rural	Remote1	Remote2
12	Naratiwat						Sisakorn Sukkirin Sungaipadi
	Pattani						Kapor Kokpoe Tungyangdang Panare Mayor Maelan Maikan Yarang Yaring Saiburi Nongchik
	Yala						Krongpinang Kabang Tantoe Bannangsata Yaha Raman
	Songkla			Ranode	Klonghoikong Kuannien Namom Bangglum Padangbesa	Tepa Chana Kasaesin Somdet_rachini	Sabayoi

HR	Province	Hospitals					
		Urban	Suburban1	Suburban2	Rural	Remote1	Remote2
12	Songkla				Rattapum Satingpa Sadao Singhanakorn		
	Satun			Langu	Kuankalong Kuandone Tapae Manang	Tungwa	

APPENDIX B

THE TABLE OF THE COMMUNITY HOSPITALS UNDER THE MOPH BY HA AREAS BY PROVINCES WHICH ATTACHED IN THE THE NOTIFICATION OF MOPH ON DECEMBER 29, 2016

HR	Province	Hospitals					
		Urban	Suburban1	Suburban2	Rural	Remote1	Remote2
1	Chiangrai		Pan Maechan Maesai	Weingpapao Teang Payamengrai Chiansan Maelao Somdetpayan	Khuntan Padad Maesaui Weingchiangrung Doiluang	Chiangkong	Maefahluoung Wiengkan
	Nan			Pua Tawangpa Pupieng Wiengsa	Chiangklang	Tungchang Nanoi Nameaun Banluang Songkaew Santisuk Maecharim	Bokleau Chalermpakiet
	Payao			Chun Dokkamtai Pukamyao Pong Maechai Pusang		Chiangmuan	

HR	Province	Hospitals					
		Urban	Suburban1	Suburban2	Rural	Remote1	Remote2
1	Phrae		Denchai Sungmen	Rongkwang Song Nongmuangkai	Long Wangchin		
	Chiangmai	Chomthong Fang Hangdong	Sanpatong Doisaket Sansei Sarapi	Chiangdao Prao Maetang Maewang Maeon Sankampang	Chaipakan Doilor Sameang Hod	Doitao Maeeai	Wianghang Aomgoi Watchan Maecham
	Maehongso n					Pai Maesariang	Kunyaum Pangmapa Maelanoi Sobmeui
	Lampang		Koka	Teon Maemo Maeta Hangchat	Ngao Chaehom Mueangpan Wangneau Sobprab Sermngam	Maeprik	
	Lampoon			Banti Banhong Pasang Maetar Wiangnonglong		Li	Tunghuachang
	Tak			Bantak Wangchao	Samgnao	Pobpra Maelamad	Tasongyang Unpang
	Pitsanulok			Bangkratum Bangrakam	Neonmaprang	Nakorntai Chattakan	

HR	Province	Hospitals					
		Urban	Suburban1	Suburban2	Rural	Remote1	Remote2
1	Pitsanulok			Prompiram Wangtong Watboad			
2	Petchabun		Wichian_ Lomsak	Nongpai Lomkao Buengsampan Sitep	Chondan Wangpong	Kaokor	Namnao
	Sukothai			Kongkailad Kirimad Tungsalium Bandanlanhoi Sinakorn Sisatchanalai Sawankalok			
	Uttaradit			Nampad Tron Tapla Pichai Lablae	Tongsankan	Fakta	Bankok
3	Chainat			Manorom Wasting Sankaburi Sanpaya	Hanka Neonkam Nongmamong		
	Kampangpet			Kanuworakburi Tungpotalay Prankatai	Klongklung Klonglan Saitongwatana Saingam Buengsamaki Lankabue	Pangsilatong	

HR	Province	Hospitals					
		Urban	Suburban1	Suburban2	Rural	Remote1	Remote2
3	Pichit		Bangmunnak Tapanhin	Popatabchang Samngam Saklek	Tabklor Potalay Wachirabarami Wangsaipun Buengnarang		
	Nakornsawan		Ladyao	Chumsang Takli Tatako Kaoliao Krokpra Payuhakiri	Takfa Banpotpisai Pisali Nongbua	Maewong Chumtabon	
	Uthaitani			Tabtan Nongkayan Nongchang	Banrai Lansak Sawangarom Houikot		
4	Nontaburi	Bangkrau Bangbua_t Bangyai Pakgred		Sainoi Bangbua_t2			
	Patumtani		Tanyaburi	Klongluang Pachatipat Ladlumkeaw Lamlukka Samkok Nongseau			
	Ayuthaya			Bangsai Bangsi			

HR	Province	Hospitals					
		Urban	Suburban1	Suburban2	Rural	Remote1	Remote2
4	Ayuthaya			Bangban Bangpahan Bangpain Banpreak Tareau Pakhai Pachi Maharat Ladbualuang Wangnoi Somdetprasankarat Uthai			
	Saraburi		Kangkoi	Donpud Banmor Muaklek Wangmoungsatatam Wihandang Saohai Nongkae Nongsang Nongdone			
	Lopburi		Koksamrong	Chaibadan Tawung	Kokchareon Taluang Patananikom Lamsonti Saboad Nongmoung		
	Singburi			Kaibangrachan Tachang Bangrachan			

HR	Province	Hospitals					
		Urban	Suburban1	Suburban2	Rural	Remote1	Remote2
4	Singburi			Promburi			
	Angtong		Wisetchaicha n	Chaiyo Pamok Potong Samko Sawangha			
	Nakornnayok			Banna Pakpli Ongkarak			
5	Kanchanaburi	Somdet_	Boploy	Tamoung Danmakamtia Saiyok Chaokunpaibun_	Takadan Laokwan Huaikachao	Tongpapum Suksirisisawat Satanpabarami Somdetpapiya_	Sangkaburi
	Ratburi		Chombueng	Chetsamien Bangpae Paktor Watpleng Suanpeung	Banka		
	Supanburi		Utong	Danchang Donjedee Dermbangnangbuad Bangplama Sipachan Samchuk	Nongyasai		
	Pachaupkirika n			Bangsapan Kuiburi Bansapannoi Pranburi Samroiyod			

HR	Province	Hospitals					
		Urban	Suburban1	Suburban2	Rural	Remote1	Remote2
5	Petburi		Chaum	Kaoyoi Tayang Banlad Banlam	Kankachan Nongyaplong		
	Samutsonkram		Napalai	Ampawa			
6	Chacheonsao		Bangnampreau Bangpakong Panomsarakam	Sanamchaiket Bangkla Banpo Planyao Ratchasan		Tatakieb	
	Prachinburi			Bansang Pachantakam Simahapo Simahosot	Nadi		
	Sakeaw				Kaochakan Klonghad Wangnamyen Watananakorn Koksung Wangsombun	Tapaya	
	Samutprakan	Banchak Banbor		Pasamutchedisawatyanon Bangsaotong			
	Chantaburi			Klung Kaokitchakut Kaosukim Tamai Makham Songpinong	Kanghangmaew Nayaiarm Pongnamron Soidao		

HR	Province	Hospitals					
		Urban	Suburban1	Suburban2	Rural	Remote1	Remote2
6	Chantaburi			Lamsing			
	Chonburi	Banglamung Banbueng Panasnikom	Pantong	Satahieb	Kosichan Botong Watyannasanwararam Nongyai Kochan		
	Trad			Kaosaming Lamngob	Klongyai Borrai	Kochang	Kokud
	Rayong		Banchan	Nikompattana Bankai Plaugdang Wangchan	Kaochamao		
7	Kalasin		Yangtalad	Somdet Kuchinarai Kamalasai Rongkam Sahasakan Kongchai Donchan	Kammuang Namon Nongkungsi Huaipueng Huaimeg Naku Samchai	Takanto Kaowong	
	Khonkan	Chumpae	Banpai	Nampong Pon Kanoun Prayean Kaosuankwang Banfang Nonesila Nongreau	Chonnabot Samsung Peaunoi Pupaman Puwieng Manchakiri Wangnoi		

HR	Province	Hospitals					
		Urban	Suburban1	Suburban2	Rural	Remote1	Remote2
7	Khonkan				Wangyai Sichompu Nongsonghong Ubonrat Kokpoechai Wiengkao Nongnakam		
	Mahasarakam		Borabue	Payakpupisai Kantarawichai Kaedam Kosumpisai Chiangyean Wapipatum	Nacheuk Nadun Cheanchom Kudrung	Yangsisurat	
	Roiet			Ponetong Suwannapum Selapum Kasetwisai Chaturapakpiman Chanhan Tawatburi Muengsuong Sisomdet Panompai Artsamat Chiangkwan	Patumrat Pochai Ponesai Nongpok Nonghi Tungkaoluang	Meyawadee	
8	Buengkan				Sopisai Pakkad Pornchareon	Seka Buengkonlon Bungkla	

HR	Province	Hospitals					
		Urban	Suburban1	Suburban2	Rural	Remote1	Remote2
8	Buengkan				Siwilai		
	Loei			Wangsapung	Chiangkan Tali Naduang Pukadueng Pureau Arawan	Dansai Pakchom Puloung Pakao	Naheaw
	Nongkai		Tabor	Ponepisai	Sichiangmai Sakai Faorai Poetak Ratanawapi	Sangkom	
	Nongbualampu			Naklang	Nawang Nonesang Sibunreang	Suwankuha	
	Udontani	Kumpawapi	Nonghan	Banpeu Pen Bandung Kudchab Nongwausar	Chaiwan Tungfon Nonesaard Pibunrak Wangsammor Sitat Sangkom Nongsang Huaikeang Kukeaw Pachaksilapakom	Nayoon Namsoam	
	Nakornpanom		Tatpanom	Sisongkam	Nakae	Natom	

HR	Province	Hospitals					
		Urban	Suburban1	Suburban2	Rural	Remote1	Remote2
8	Nakornpanom			Tauten Wangyang	Nawa Banpang Plapak Ponesawan Renunakorn		
	Sakonnakon			Wanornniwas Koksisupan Taongoi	Kudbak Kusuman Kamtakla Chareonsin Banmuang		
	Sakonnakorn				Paarchanban Paarchanphun Pungkone Ponnakeaw Waritpum Songdao Akartamnoui	Nikomnamun	
9	Chaiyapum			Kangkor Bamnetnarong Pukieu Nongbuadang Bankewa	Kasetsombun Kornsawan Kornsan Chasturas Tepsatit Neonsanga Bantan Nongbuaraheal Subyai	Pakdichumpon	
	Nakornratchasima		Pimai Chokchai Paktongchai	Kornburi Chakarat	Kangsanamnang Kamsakaesang Kong	Somdetya_my	

HR	Province	Hospitals					
		Urban	Suburban1	Suburban2	Rural	Remote1	Remote2
9	Nakornratchasima			Chumpoung Dankuntod Buayai Patai Sikew Sungneon Kamtalaysor Chalermpakiet Nonetai Nonesung	Nonedang Banleaum Patongkam Lamtameinchai Wangnamkiew Seangsang Nongbunnak Huaitalang Bualai Teparak Sida		
	Buriram		Pakonechai Lampaimas	Puttaisong Lahansai Sateuk Kasang Huairat	Cumuang Candong Chalermpakiet Chamni Napoe Nonesuwan Bankruad Banmaichaipot Pacam Pubplachai Nongki Nonghong Bandan	Nonedindang	
	Surin		Sangca	Tatum Ratanaburi Sikarapum Kewasirin Chompa	Kabcheang Chumponburi Buached Sanom Samrongtab	Panomdongrak	

HR	Province	Hospitals					
		Urban	Suburban1	Suburban2	Rural	Remote1	Remote2
9	Surin			Lamduan	Nonenarai Sinarong		
10	Mukdahan			Nikomkamsoi	Kamchaee Dontan Wanyai	Dongluang Nongsung	
	Yasotorn			Leangnokta Saimoon Patew Mahachaichana	Kudchum Korwang Kamkeankeaw Thaichareon		
	Sisaket		Kantararak Rasisalai Utumpornpisai	Kukun Kunhan Yangchumnoi Payu Poesisuwan	Kantrarom Buengbun Bencharak Prangku Pribueng Wanghin Sirattana Huaitabtan Silalad	Namkliang Nonekoon Pusing Muangchan	
	Ubonratchatani		Pibunmansahan	Takanpeadpon Kuangnai Laosuaukok	Kudkaopun Kemmarat Kongcheam Donmoddang Tansum Tungsiudom Moungsamsib Simuangmai Samrong Sirintorn Natan	Namyean Buntarik Poesai	Nachaluai

HR	Province	Hospitals					
		Urban	Suburban1	Suburban2	Rural	Remote1	Remote2
10	Ubonratchatani				Nayia Namkun Nayia		
	Amnartchareon			Lueamnart	Patumratwongsa Pana Senangkanikom Huatapan	Chanuman	
11	Chumporn			Lungsuan Patew Paknamchumpor n Sawee	Tungtaco Paknamlungsuan Tasae Mabammarit Lamae	Patoh	
	Nakornsitammar at		Tasala Pakpanung Ronpibul	Chawang Chienyai Promkiri Lansaka paprom	Kanom Chulaporn Chauad Tungyai Nabon Huasai Portanklai__ Chalerm_ Nobpitam	Tampannara Bangkun Pipoon	
	Surattani		Kanchanadit Tarongchang Bannasan Wiengsa	Tachang Punpin	Kiriratniyom Kiensa Chaiya Donsak Tachana Bantakun Bannaderm	Kopangan Chaiburi Wipawadi	

HR	Province	Hospitals					
		Urban	Suburban1	Suburban2	Rural	Remote1	Remote2
11	Surattani				Panom Prasang		
	Krabi			Kaopanom Neauklong Aoleuk	Klongtom Plaipaya Lamtub		Kolanta Kopipi
	Pangnga			Takuatung Tubpud	Kaponchaipat Taimuangchaipat Bangsai	Kuraburichaipat	Koyaochaipat
	Phuket	Patong Talang					
	Ranong				Kaburi Kaper	Laun Suksamran	
12	Pattalung		Kuankanun	Kaochaison Bangkeaw Pabon Papayom Sinakarin	Tamoad Pakpayoon Sibunpot	Kongrha	
	Trang		Huaiyod	Kantrang Nayong Yantakao Sikao	Palien Ratsada Wangwiset Hadsamran		
	Naratiwat						Ranhae Lueseau Yinhor

HR	Province	Hospitals					
		Urban	Suburban1	Suburban2	Rural	Remote1	Remote2
12	Naratiwat						Chanae Cheairong Takbai Bachea Wang Sisakorn Sukkirin Sungaipadi
	Pattani						Kapor Kokpoe Tungyangdang Panare Mayor Maelan Maikan Yarang Yaring Saiburi Nongchik
	Yala						Krongpinang Kabang Tantoe Bannangsata Yaha Raman
	Songkla			Ranode Singhanakorn	Klonghoikong Kuannien Namom Bangglum	Tepa Chana Kasaesin Somdet_rachini	Sabayoi

HR	Province	Hospitals					
		Urban	Suburban1	Suburban2	Rural	Remote1	Remote2
12	Songkla				Padangbesa Rattapum Satingpa Sadao		
	Satun			Langu Kuandone Tapae	Kuankalong Manang	Tungwa	

Note: Black letter are the unchanged areas, Blue letter are the changed areas, Brown letter are the new areas.

APPENDIX C

THE TOP 25 PROVINCES WHERE EARN THE HIGHEST REVENUE IN 2013

	Provinces	Sum of Revenue (Million Baht)	District
1	Nontaburi	562.78	
2	Songkla	466.02	Hatyai
3	Patumtani	455.05	
4	Rayong	372.45	
5	Surattani	325.44	
6	Phuket	313.97	
7	Chonburi	262.66	Pattaya
8	Chiangmai	251.33	
9	Nakornratchasima	213.38	
10	Samutprakan	207.53	
11	Khonkan	181.59	
12	Prachaupkirikan	154.57	Huahin
13	Nakornsitammarat	139.72	
14	Nakornpathom	137.11	
15	Udontani	132.03	
16	Nakornsawan	125.87	
17	Samutsakorn	124.91	
18	Ubonratchatani	118.47	
19	Trang	104.30	
20	Lampang	100.26	
21	Chiangrai	92.11	
22	Pitsanulok	86.96	
23	Petburi	84.54	Chaum
24	Saraburi	82.44	
25	Ayuthaya	81.47	